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REVISION OF EAST PALEARCTIC *APATANIA* (TRICHOPTERA: APATANIIDAE)

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REVISION OF EAST PALEARCTIC *APATANIA* (TRICHOPTERA: APATANIIDAE)

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ABSTRACT

The East Palearctic genus *Apatania* Kolenati includes 34 species. Thirty-two of these have been described as adults and the other 2 are known only in the larval life stage. Immature stages of most species are not yet known.

A morphological study of these species suggested that 2 of the nominal species are synonyms of other species, reducing the number of valid East Palearctic *Apatania* species to 30. A phylogeny and classification of the reviewed 30 species is provided for this work. My work does not support Schmid's (1953) groupings of *Apatania* species. Although recognition of homologues was problematic among the highly diverse genitalia, I was able to infer new monophyletic groups among the East Paleartic species. Eight new species groups (the *Apatania tsudai*, *A. momoyaensis*, *A. zonella*, *A. copiosa*, *A. chokaiensis*, *A. parvula*, *A. stigmatella* and *A. siniaevi* Groups) and 5 species *incertae sedis* are recognized.

Examination of adult males and females resulted in 2 subjective synonyms; *Apatania crassa* Schmid, 1953, is junior synonym of *A. parvula* Martynov, 1935; and *A. doehleri* Schmid, 1954, is junior synonym of *A. majuscula* McLachlan, 1872.

Keys are provided for identifcation of the 30 valid species based on male and female genitalia. Intraspecific variations also are illustrated.

This is the first comprehensive phylogenetic review of East Palearctic *Apatania* species and conflicting and supporting evidence for homologies of genitalic structures is considered.

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TABLE OF CONTENTS

Page

Table of Contents (Continued) Page

LIST OF TABLES

Table Page

LIST OF FIGURES

List of Figures (Continued)

Figure Page

List of Figures (Continued)

Figure Page

CHAPTER I: INTRODUCTION

The caddisflies of family Apataniidae (insect order Trichoptera, suborder Integripalpia, infraorder Plenitentoria) are relatively small insects whose larvae construct slightly tapered cases of small rock fragments and typically live in cold water such as glacial lakes and high altitude streams and rivers (Gall 1994, Wiggins 2004). Life history and larval descriptions are known for only a few species of the family. Adults are univoltine, relatively small, with wings more brown or dark brown than other Limnephiloidea. They are widely distributed throughout the northern hemisphere.

Apataniidae was originally described as a family by Wallengren (1884, 1886), but most authors until recently considered the group a tribe or a subfamily Apataniinae in family Limnephilidae (e.g., Schmid 1953, 1954). Gall (1994, 1997) elevated the group back to family status, distinct from Limnephilidae. The family Apataniidae is a strongly supported monophyletic group and forms a polytomy with four other families of superfamily Limnephiloidea (Kjer et al. 2002, Holzenthal et al. 2007). The 197 currently valid species of Apataniidae have been classified as shown in Appendix A and with the indicated distribution (Morse 2008). Eighteen genera, 8 of which are monotypic, belong to 2 subfamilies, Apataniinae and Moropsychinae.

The genus *Apatania* Kolenati 1847, is one of the largest genera in subfamily Apataniinae, with at least 95 valid species, 34 of which are in the East Palearctic Biogeographical Region.

The genus *Apatania* was divided by Schmid (1953) into informal supergroups, groups, and subgroups. He divided the *Apatania* species into three supergroups (the

Apatania complexa, *A. fimbriata* and *A. wallengreni* Groups), which were based on diagnostic sexual dimorphism observed in the forewing pterostigma region. Schmid's results were based on descriptions of several representative species in these groups. His inferences of the phylogenetic relationships within the genus *Apatania* were based on evidence that was not reported in his work and it is doubtful that modern cladistic methods were employed.

For the East Palearctic caddisflies of Apataniidae, the Lake Baikal (Ivanov and Menshutkina 1996) and Japanese (Nishimoto 1997) species have been revised. However, up to now the genus *Apatania* has not been analyzed with modern phylogenetic techniques and superspecific taxa in the genus are based on subjective opinions only.

There have been many different hypotheses inferred about the evolutionary history of caddisflies, primarily from morphological evidence (Morse 1997). Based on these phylogenies, many conflicting genus-group synonyms have been proposed, creating confusion about these taxonomic categories (Forsslund 1942; Schmid 1953, 1954; Kobayashi 1973).

Consequently, a full review of the phylogeny of the species in this genus is needed, using as many characters as possible, both molecular and morphological, and using the most reliable and explicit methods available. Such a revisional work should be a fundamental comparative investigation based on both published species descriptions and museum material, especially for phylogenetic analyses, involving as many different morphological features as possible: genitalia, wing venation, and other body characters of adult males and females, pupae, larvae, and eggs. This revision will contribute data for

resolving diagnostic and phylogenetic issues and also will add to our understanding of the life histories and habitat and pollution tolerances of these species. This information will help to build biotic indices so that these species can be used more effectively for the biomonitoring of water quality.

Molecular studies are needed that analyze sequences of several genes that collectively are informative over a broad range of time. Such a phylogenetic study and resulting taxonomic revision will be important for understanding the origins and modern distribution of the fauna of this family globally and for providing a foundation for ecological research. The North American and European species of *Apatania* are well-known. Studies of immature stages of *Apatania* and of molecular sequences of *Apatania* species are beyond my present resources. Mongolia is part of the East Palearctic Region. One hundred and sixty species of caddisflies are known from the country, including 5 species of *Apatania*, some of which are relatively ubiquitous and abundant in the northcentral part of the country. Mongolian biomonitoring projects encounter one or more *Apatania* species in nearly every sample, making an understanding of their diagnosis, biology, and historical relationships especially important.

Consequently, I focused on an analysis of the morphology of adults of East Palearctic species in the genus in order to provide an improved understanding of the number of species of *Apatania* in this part of the world and to infer the phylogenetic relationships among these species. Thus, the purposes of this study are to determine diagnostic morphological characters of males and females of East Palearctic *Apatania* species, and to determine phylogeny and their biogeography.

CHAPTER II: MATERIALS AND METHODS

2.1. Specimen preparation and observation

Methods used for preparation of specimens followed by Blahnik & Holzenthal (2004), and Blahnik et al., (2007). The abdomens were cut between segments III and IV and soaked in either 12% potassium hydroxide (KOH) or a solution of 85% lactic acid heated on the hot plate for 15-20 minutes, in order to digest ("clear") non-chitinous tissue. Cleared abdomens were passed to distilled water to remove the base or acid, and then transferred to 80% ethyl alcohol for cleaning remaining debris with a fine needle syringe and permanently stored in glycerin. Wings of the specimens were dry mounted on microscope slides. Digital images of head and thoracic structures, wings, and genitalia were acquired with a Meiji Techno RZ dissecting microscope equipped with a ProgRes® C5 digital camera. The forewing and hind wing length measurements were made using ProgRes® Capture Pro image capture software. These images were reduced to 18 X 23 cm and printed. All drawings were made by tracing the printed digital images, then details of the genitalia were added by examining them in glycerin using a Meiji Techno RZ dissecting microscope.

2.2. Material

Material for this study was borrowed from the following persons and institutions:

- Clemson University Arthropod Collection, Clemson, South Carolina, USA (CUAC)

- Institute of Biology and Soil Science, Far Eastern Branch of Russian Academy of Science, Vladivostok, Russia (IBSS)
- Nanjing Agriculture University, China (NAU)
- Personal collection of Hiroyuki Nishimoto, Japan (HN)
- Personal collection of David Ruiter, U.S.A. (DR)
- Personal collection of Juha Salokannel, Finland (JS)
- Zoological Museum, University of Copenhagen, Denmark (UMC)
- Museum für Naturkunde (Humboldt Museum of Berlin), University of Berlin, Germany (ZMHB)
- Selenge River Project Sample: Academy of Natural Sciences of Philadelphia, U.S.A. (ANSP), Clemson University Arthropod Collection (CUAC), Mongolian Academy of Sciences Biological Institute (MAS).

2.3. Phylogenetic method

The characters used for separation of supergroups, groups, and subgroups by Schmid (1953) are unreliable. Most of these were sexually dimorphic characters in the forewing pterostigma, which are not constant and are also found in other Apataniinae tribes. His groups were based on the relative complexity of male and female genitalic structures.

I examined the external morphologies of adult males and females only, since other life history stages are insufficiently known to contribute significantly to a phylogenetic analysis. A total of 34 nominal species of *Apatania* have been reported in

the East Palearctic Region. Two of these species are known only as larvae and were not considered further in this research. Two species are known only from females and may be parthenogenic. In this study, males of 28 species and females of 22 species were reviewed. Specimens of 16 species were studied, including males of 14 species and females of 15 species. Characters for males and females of the other species were found in published descriptions and illustrations.

For the phylogenetic analysis, an outgroup was determined by the following considerations. The tribe Apataniini, as defined in this work (Table 1), includes the genera *Apatania*, *Apataniana* Mosely 1936, *Apatidelia* Mosely 1942, and *Talgara* Mey 1991. *Apatania* and *Apatidelia* share 2 synapomorphies: hind wings each with an open discoidal cell and hind wings each with crossvein m-cu occurring after the bifurcation of Cu1 (or M3 and Cu1a are confluent over a short distance) (Mey 1991a). *Apataniana* and *Talgara* share 3 synapomorphies: male harpagones each with more than 1 large spine, females with filamentous appendages on tip of the vulvar scale, median process undivided apically and arising from the basal dorsum of X segment (Mey 1991a). Published information indicates little morphological divergence of *Apatidelia* (adult sternum V with lateral lobes) from *Apatania* (adult sternum V lateral lobes absent) and no specimens of the 3 species of *Apatidelia* were available for study. *Talgara* includes only 1 known species and is distinguished from *Apatania* by the 3 *Apataniana-Talgara* synapomorphies and 2 autapomorphies: female abdominal segment IX divided into 1 tergal and 2 vestigial sternal sclerites, with fusion of tergum and sternum VIII into sclerotized ring, and male maxillary palp segment I enlarged, with thick hairs, and

segment II curved dorsad. As a monotypic genus basal to *Apataniana*, the validity of *Talgara* is subjective. Therefore, *Apataniana* was used as the outgroup to polarize characters in my analysis.

Among all possible characters, those selected for the analysis were chosen because of their likely phylogenetic information content. The selected characters and their polarities are shown in the Table 2. The plesiomorphic states were coded as "0," the apomorphic states as "1," and missing data as "?" in a data matrix (Table 3). The phylogenetic relationships were inferred by observation of a nested hierarchy of uniquely shared homologues (synapomorphies) (e.g., Schuh, 2000) in the data matrix. The metrics of the resulting cladogram were calculated by hand.

CHAPTER III: ADULT MORPHOLOGY

3.1. Head

External structures (Ivanov 1990, Frania and Wiggins 1997) and internal morphology (e.g., nervous systems, tentorium associated with muscles (Crichton 1957, Neboiss 1989) of the adult caddisfly head have been studied. Oláh and Johanson's (2007) terminology for setal warts and grooves and Crichton's (1957) terminology for mouthparts are followed in my study.

Head of *Apatania* reddish brown, appendages of head fuscous. Head (Fig. 3.1) with 3 ocelli. In dorsal view (Fig. 3.1C), pair of vertexal medioantennal setal warts (vmx.sw.) close to each other behind median ocellus. Pair of vertexal lateroantennal setal warts (vlc.sw.) farther apart behind antennal socket. Pair of vertexal medioocellar diffuse setal warts (vmd.sw.) behind 2 pairs of vertexal setal warts, along the coronal groove. Pair of larger, transverse, oval occipital setal warts (occ.sw.) on occiput. Pair of postgenal setal warts (pge.sw.) along posterior edges of compound eyes. In anterior view (Fig. 3.1B), single median frontoclypeus setal wart (fc.sw.) filling space between frontogenal grooves (fg.g.). Pair of clypeogenal setal warts (cg.sw.) between compound eyes and frontogenal grooves, sometimes filling these spaces and sometimes smaller. Antennae uniformly brown, reaching or slightly longer than forewings. Antennal scapes (scp.) shorter than head length. Maxillary palps (mx.p.) 3-segmented in male (Fig. 3.1A), 5-segmented in female. Labial palps (lab.p.) 3- segmented in both sexes. Pads of sensilla (sens.p.) present on terminal segment of each maxillary and labial palp.

3.2. Thorax

Ivanov's (1990) terminology is followed in my study for thoracic segments. Thorax (Fig. 3.2) of *Apatania* reddish brown. Pronotum (pntm.) of prothorax much shorter than other thoracic segments, bearing 2 pairs of setal warts. Medial pronotal setal warts (md.pt.sw.) transversely oval, large. Lateral pronotal setal warts (lt.pt.sw.) circular and small.

Mesonotum (ms.ntm.) of mesothorax composed of mesoscutum (ms.sct.) anteriorly, mesoscutellum (ms.sctl.) posteriorly. Mesoscutum narrowing posteriorly and with pair of large oval scutum setal warts (sct.sw.) anteriorly and pair of small warts (sm.sw.) posteriorly, these small warts sometimes present and sometimes absent, even in same species. Mesoscutellum triangular, with pair of large subtriangular scutellar setal warts (sctl.sw.), placed on anterolateral edges of mesoscutellum. Postmesoscutellum (pms.sctl., metathoracic antecosta) saddle-shaped, posterior margin connected with metascutum.

Metanotum (mt.ntm.) of metathorax composed of metascutum (mt.sct.) anteriorly, metascutellum (mt.sctl.) posteriorly. Anterior margin of metascutum broadly notched medially, metascutellum subtriangular, broadly pointed anteriorly and gradually widened posteriorly.

Legs generally brown, with basal segments darker and apical segments lighter. Legs with tibial spurs 1, 2, 4 on each foreleg, midleg, and hind leg, respectively.

Wing color varied because of different fixation methods, generally light brown. Typical wing venation of *Apatania*, similar in males and females, shown in Figure 3.3. Ruiter's (2000) terminology for venation for caddisflies is followed in my study.

Each forewing of *Apatania* with subcosta (Sc) abruptly angled anterad to notched costal margin (C), Sc and first radial vein (R1) connected with subcostal-radial cross vein (sc-r) at this angle, forming distinctive truncate basal border of pterostigma. Pterostigma with thick, deciduous androconial hairs. Discoidal cell (dsc.cl.) short and thyridial cell (thd.cl.) long. Cubital cross vein (cu) connecting first and second cubital veins (Cu1 and Cu2) subapically at point where Cu2 angled abruptly to hind margin. Anal veins (A1, A2, A3) short, looped and fused apically into single vein. Forks I, II, III, and V present.

Hind wing with mostly 3, but some species of *Apatania* with 4 frenular setae (fr.st.) at base of frenulum. Some species of *Apatania* with short basal row of several setae/hamuli on anterior margin of cubital vein (C) for wing coupling. Typically with lower posterior side of forewing and upper anterior edge of hind wing with several short setae/hamuli for wing coupling. Hind wing discoidel cell open, thyridial cell (thd.cl.) long. Posterior median vein (M3+4) and anterior Cu1 vein (Cu1a) fused for short distance, without m-cu crossvein. Forks I, II, III, and V present. Some *Apatania* species (and some *Manophylax* species) with pseudovein anterior of Cu vein (indicated by dashed line in Fig. 3.3B).

3.3. Genitalia

Nielsen's (1957, 1980) terminology for male and female genitalia is followed in my study. Male genitalia terms are shown in Figs. 4.1, 4.3, 4.6, 4.17 and 4.27; recognition of homologues was problematic among female genitalia, therefore female genitalic terms are shown in each figure.

Male genitalia (Figs. 4.1 – 4.30) extremely variable in structure among species groups and among species. Segment IX annular, short dorsally, forming narrow transverse dorsal band, occasionally with row of long setae ventrolaterally. Inferior appendages (inf.ap.) usually cylindrical, bearing numerous setae; harpagones (hrp.) each more slender than its inferior appendage and usually curved mesad with pointed apex. Superior appendages (sp.ap.) of segment X usually present with few setae, in some species absent or fused with external branches of segment X (ext.br.). External branches usually long, variable in shape, in most cases with setae ventrally. Internal branches of segment X (int.br.) present and produced in few species, but mostly fused with external branches. Median process of segment X (me.pr.) mostly composed of single process, but in some species composed of pair of processes or single process with bifurcate apex. The body of segment X (bo.X.) with variable shape, mostly composed of pair of semi-membranous processes, and dorsoventrally depressed or laterally compressed. Phallus with cup-like phallobase (phb.), phallicata (phl.) tubular and mostly heavily sclerotized, sometimes with membranous process (end.) and/or bearing bristles. Parameres (prm.) slender, tapered apically, each usually with straight tip, but in some cases truncated or serrated on inner margin.

Female genitalia (Figs. 4.31 - 4.53) segment IX (IXa, b, c, d) with variable shape, usually separated laterally from segment X, in some species lateral lobe well-developed. Segment X (Xb, c, e.) mostly forming finger-like processes or small protuberances. Supragenital plate (Xe.) distinct, usually sclerotized. Sternum IX (e.gon.IX.) mostly membranous and triangular shaped vulvar scales (Unzicker 1968), connect with lateral lobe of segment IX (IXd). Sternum VIII (e.gon.VIII.) apically with transversely striated vulvar lobe of various lengths and shapes, but usually long, slender and thumb-like. Anal opening visible apically in some species (Figs. 4.40C, 4.42C, an.).

CHAPTER IV: PHYLOGENY AND SYSTEMATICS

FAMILY Apataniidae Wallengren

Family Apataniidae has been treated as a subfamily in family Limnephilidae for a long time, even though the family was established (Wallengren 1884) with obvious diagnostic characters of maxillary palps and wing venation that distinguish it from other families. There are several different approaches to distinguish the family Apataniidae from other closely related families in Integripalpia. Gall (1994) separated family Apataniidae from families Uenoidae, Goeridae and Limnephilidae (superfamily Limnephiloidea) based on geographic distribution, habitat, and types of material and construction method of larval cases. Kjer et al. (2002), showed that same result, but their molecular phylogenetic analysis indicated that families Apataniidae and Limnephilidae are sister taxa, more closely related to each other than to families Rossianidae, Uenoidae and Goeridae.

Several characters that distinguish adults of Apataniidae from those of other families in superfamily Limnephiloidea include the following: ocelli present, paralabral setae or setose sclerites present, a short labrum (its basal part almost equal to or only slightly shorter than its distal part), anal area of hind wings weakly developed, and fork I of hind wings absent or petiolate (stalked).

SUBFAMILY Apataniinae Wallengren

Species of family Apataniidae have been divided into 2 subfamilies (Apataniinae and Moropsychinae) and 4 genera incertae sedis (Table. 1). Species of subfamily Apataniinae

differ from other species among the family Apataniidae by having tibial spurs 1, 2, 4 on each foreleg, midleg, and hind leg, respectively. Species of the other subfamily, Moropsychinae, have tibial spurs 1, 3, 4.

TRIBE Apataniini Wallengren

Subfamily Apataniinae is divided into 3 tribes (Apataniini, Baicalinini and Thamastini) and 1 monobasic genus *incertae sedis* (Table. 1). Species of tribe Apataniini are a monophyletic group within subfamily Apataniinae, as evidenced by each forewing SC vein uniquely abruptly angled anterad to the costal margin at the level of crossvein sc-r, forming a distinctively truncate basal border of the pterostigma.

GENUS *Apatania* Kolenati, 1847

Apatania Kolenati, 1847: 33, 75; type species: *Apatania wallengreni* McLachlan (petitioned by Kimmins, 1959; accepted by Commission on Zoological Nomenclature, 1961).

Apatidea McLachlan, 1875: 33; type species: *Apatidea copiosa* McLachlan (selected by Mosely, 1936; Ross, 1944); synonymized by Thienemann, 1926: 274.

Apatelia Wallengren, 1886: 78 (as a subgenus of *Apatania*); type species: *Phryganea fimbriata* Pictet (selected by Mosely, 1936).

Archapatania Martynov, 1935: 324; type species: *Archapatania complexa* Martynov (original designation); synonymized by Schmid, 1953: 150.

Gynapatania Forsslund, 1942, in Forsslund & Tjeder, 1942: 95; type species: *Apatania muliebris* McLachlan (original designation); synonymized by Thienemann, 1950: 146.

Parapatania Forsslund, 1934: 381; type species: *Phryganea stigmatella* (Zetterstedt) (monotypic); synonymized by Forsslund, 1953: 146.

The genus *Apatania* has the largest number of species of any genus in the tribe Apataniini (Morse 2008, Table 1). The species of *Apatania* differ from those of other genera in the tribe by having an open discoidel cell on each hind wing and a short distance m-cu cross vein between M3+4 and Cu1a in each forewing. Both of these characters appear to be synapomorphic in Apataniinae, indicating that *Apatania* is probably a monophyletic group (Table. 2).

Twenty-one phylogenetically informative morphological characters of *Apatania* species are listed in Table 2 and summarized in the character matrix of Table 3, resulting in the cladogram shown in Figure 1. The 30 East Palearctic *Apatania* species for which adults are known apparently belong in 8 monophyletic groups, with 6 species *incertae sedis* (Table. 5).

Apatania tsudai Group

Synopsis of characters. Male genitalia with ventral process (ve.pr.) on segment IX (synapomorphy 7), harpagones long (plesiomorphy), superior appendages small (phylogenetically equivocal), and external branches of segment X cylindrical (phylogenetically equivocal). This group contains 2 species.

Apatania tsudai Schmid

Figures 4.1 and 4.31

Apatania tsudai Schmid 1954: 16-18, fig. 53a-e [adult male genitalia].

Apatania tsudai Schmid 1955: 82 [checklist].

Apatania tsudai Schmid; Kobayashi 1983: 53, figs. 5a-e [adult male genitalia].

Description. Male (n=3), forewing length 7.5 mm, hind wing length 7.0 mm; female (n=2), forewing length 8.0 mm, hind wing length 7.2 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.1). Segment IX dorsally short, pair of processes (ve.pr.) arising ventrolaterally. Inferior appendages cylindrical, each with base very narrow; its harpago curved mesad and tapered apically with somewhat expanded base. Superior appendages very small; external branches subcylindrical, each with sinuate ventral margin; single median process shorter than external branches, directed slightly ventrad but with upturned tip. Body of segment X triangular in lateral view, apically emarginate in dorsal view with pair of rounded extensions. Phallicata curved ventrad, bifurcate at apex, bearing many bristles along each side, endothecal membrane visible. Parameres slender, acute apically and curved laterad.

Female genitalia (Fig. 4.31). Segments IX and X separated apicolaterally; lateral lobes of segment IX (IXd) slightly developed, posterior of segment IX (IXb) long and undivided apically, bearing several setae, sternum IX with pair of elongated membranous vulvar scales (e.gon.IX.) connected with lateral lobes(IXd). Sternum VIII with short rectangular

vulvar lobe (e.gon.VIII). Supragenital plate (Xe) sclerotized, broadly rounded apically. Segment X (Xc) visible in lateral and ventral views, apically slightly emarginated. Anal opening (an.) visible ventrally.

Diagnosis. The male of this species resembles that of *A. kyotoensis* Tsuda (Fig. 4.2), but differs from it by having stout bristles along the sides of the phallicata. The female of this species is similar to that of *A. complexa* Martynov (Fig. 4.54), but differs from it by having segment Xc visible in lateral view and by the longer internal structures of the spermathecal sclerite (spt.sc.).

Distribution. Japan (Minamasumi, Tagasegawa Province; Mei Prefecture).

Material examined. JAPAN: Nakano-cho, Yokkaichi-shi, Mie Pref., 13 Apr 1996, H. Nishimoto, 3 males, 2 females (in 70% ethanol).

Apatania kyotoensis Tsuda

Figure 4.2

Apatania kyotoensis Tsuda 1939b: 291, pl. 15, figs. 6-8 [adult male genitalia and wings].

Apatania kyotoensis Tsuda 1942: 332 [bibliography].

Apatania kyotoensis Tsuda; Kobayashi 1983: 47, figs. 1a-c [adult male genitalia].

Apatania nikkoensis Schmid 1954: 18, fig. 54 [misidentification: adult male genitalia].

Apatania kyotoensis Tsuda; Schmid 1955: 82 [checklist].

Description. Translation from German, Tsuda 1939b. “Male genitalia. Representation of genital appendages: without visible preanal appendages. The extension of tergite IX long straight dorsally, broader at base, apical part gradually narrowed, in lateral view slim, curved downward, slightly broader at the basis. External branches of tergite X slender, long, basally hardly broader than apically. Inferior

> appendages much longer than in *A. nikkoensis*. Basal part with concave apex. Second part [harpago] basally thick, apically narrow, bent dorsally at middle."

Male genitalia (Fig. 4.2). Segment IX short dorsally, cylindrical pair of ventral processes arising apicoventrally. Inferior appendages cylindrical, extremely narrowed basally; harpagones each with base expanded somewhat, apically elongated, curved ventromesad. Superior appendages very small; external branches long, cylindrical, each with ventral margin slightly serrate; single median process shorter than external branches, curved ventrad from near base. Phallicata curved ventrad, with pointed apex, small triangular endotheca arising dorsally before apex. Parameres long, slender, tapered apically. Female unknown.

Diagnosis. This species is similar to *A. tsudai*, but is easily distinguished by a lack of stout bristles along the sides of the phallicata.

Distribution. Japan (Kyoto).

Material examined. None.

Apatania momoyaensis Group

Synopsis of characters. Inferior appendages each with a basal projection (synapomorphy 6); superior appendages fused with external branches (phylogenetically equivocal); external branches short (plesiomorphy), harpago long (plesiomorphy). This group contains 2 species.

Apatania momoyaensis Kobayashi

Figure 4.3

Apatania momoyaensis Kobayashi 1973: 34, pl. 8, figs. A-D [adult male genitalia and wings].

Description. From Kobayashi 1973. "Forewing length 8.5 mm, hind wing length 6.7 mm. Male genitalia. IX segment rather narrow covered by VIII segment, frontal margin of X segment curved inwards; upper part produced upwards, lower part produced produced backwards. Inferior appendage long, 2-jointed; basal joint thick, long; basal joints produced backwards, nearly triangule; terminal joint thin, shorter than basal joint, acuted at its apex. Penis long, divided into 2 long lobes, apical portion of each lobes with a few long spines."

Male genitalia (Fig. 4.3). Segment IX ventrally elongate. Inferior appendages cylindrical, each with basal projection (inf.bp) produced posterad; with its harpago long, curved ventromesad. Superior appendages fused with external branches; external branches short subtriangular; median process small, triangular, visible in caudal view. Body of segment X triangular, beneath median process, visible in caudal view. Phallicata deeply notched, apicolateral rods each bearing several bristles along lateral edge, short bristles in base of notch. Parameres (prm.) long, slender, apically pointed, curved ventromesad.

Female unknown.

Diagnosis. The male of this species is similar to that of *A. tcharvakensis* Ivanov, but is easily differentiated from it by the triangular shape of its median process and by the presence of bristles on the phallicata.

Distribution. Japan (Akita Prefecture).

Material examined. None.

Apatania tcharvakensis Ivanov

Figure 4.4

Apatania tcharvakensis Ivanov 1991: 8, figs. 4a-e [adult male genitalia].

Description. From Ivanov 1991. "Forewing 9.0 mm. Male genitalia. Segment IX curved posterad, its raised hind part lacking dorsal sutures. Preanal appendages short, broad with acute end, large inner tooth, and small external and inferior teeth. Segment X divided into 2, provided with large subapical and apical teeth directed outwards. Inferior appendages with massive basal and extended apical segments; basal segment with ventrocaudal teeth and faint apical narrowing, thin apical segment bent ventrad and cut apically. Aedeagus swollen in the middle part, with ventral process and strong dorsal tooth at each side in the distal part, several setae at apex."

Male genitalia (Fig. 4.4). Segment IX laterally longer anteriorly. Superior appendages fused with external branches; external branches short subtriangular lobes; median process divided into 2 projections, each acute apically. Body of segment X fused with median process. Phallicata deeply notched, apicolateral branches each bearing 2 spines. Parameres long, slender, apically pointed and curved ventrolaterad.

Female unknown.

Diagnosis. The male of this species is similar to that of *A. momoyaensis*, but is distinguished from it by having a pair of 2 apically pointed median processes and each apicolateral branch of the phallicata with only 2 bristles.

Distribution. Uzbekistan (Tchirtchik).

Material examined. None.

Apatania zonella Group

Synopsis of characters. Male genitalia: inferior appendages each with apicoventral projection (synapomorphy 8); harpagones short (synapomorphy 5); external branches cylindrical, long (synapomorphy 12); phallicata with bristles (phylogenetically equivocal). Female genitalia: lateral lobe of segment IX (IXd) well developed (synapomorphy 9). This group contains 7 species.

Apatania zonella (Zetterstedt)

Figures 4.5 and 4.32

Phryganea stigmatella var. *zonella* (Zetterstedt) 1840: 1066 [description].

Gonotaulius arcticus Boheman 1865: 568; a synonym of *Apatania zonella* (Zetterstedt) according to Fischer 1967: 128.

Apatania arctica (Boheman); McLachlan 1880: 216, pl. 24, figs. 1-3 [female genitalia].

Apatania inornata Wallengren 1886: synonymized by Kimmins 1951: 410-416 [male and female genitalia].

Apatania arctica (Boheman); Morton 1902: 156, pl. 3, figs. 13-19 [female genitalia].

Apatania palmeni Sahlberg 1894: 5,6, 12, 18, figs. 1-2; doubtfully same species as *Apatidea arctica* (Boheman) according to Forsslund 1928: 58, 59; a synonym of *Apatidea arctica* (Boheman) according to Nielsen, 1950: 400).

Apatania groenlandica Kolbe 1912: 41; synonym of *Apatania zonella* (Zetterstedt) according to Fischer 1967: 129.

Apatania arctica (Boheman); Martynov 1914: 47 [redescription].

Apatelia arctica (Boheman), *inornata* (Wallengren), *and palmeni* (Sahlberg); Martynov 1917: 61 [distribution].

Apatelia arctica (Boheman); Martynov 1928: 477 [distribution].

Apatania stigmatella (Zetterstedt); Ulmer 1927: 9 [distribution].

Apatania arctica (Boheman); Mosely 1929: 502 [distribution].

Apatania zonella (Zetterstedt) Forsslund 1929: 189 [distribution].

Apatania arctica (Boheman); Mosely 1930: 237, figs. 1-3 [male genitalia].

Apatania arctica (Boheman); Mosely 1931: 34 [description note].

Apatelia zonella (Zetterstedt); Martynov 1935: 323 [distribution].

Apatidea zonella (Zetterstedt); Kimmins 1951: 411, figs. 1a-d [male genitalia].

Apatania zonella (Zetterstedt); Schmid 1954: 30, figs. 67-69 [male and female genitalia].

Apatania zonella (Zetterstedt); Schmid 1955: 82 [checklist].

Apatania zonella (Zetterstedt); Lepneva 1971: 158-162, figs. 208-213 [larval description].

Apatelia zonella (Zetterstedt); Svensson & Tjeder 1975: 269 [checklist, distribution].

Apatania zonella (Zetterstedt); Mey & Dulmaa 1985: 93 [checklist, distribution].

Apatania zonella (Zetterstedt); Ivanov & Melnitsky 2007: 33 [distribution].

Apatania zonella (Zetterstedt); Mey 1991b: 356 [checklist].

Description. Female (n=3), forewing length 8.5 mm, hind wing length 7.2 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.5). Segment IX short dorsally. Inferior appendages semi-cylindrical, each with distal projection at apicoventral edge; its harpago short, composed

of upper and lower lips, visible in lateral and dorsal aspects. Superior appendages short, cylindrical; external branches ventrally sinuate, each bearing several setae ventrally; single triangular median process apically narrowed. Body of segment X fused with median process. Phallicata bearing several short blade-like setae ventrally, minute bristles dorsally, phallicata apically notched. Parameres long, slender, apically pointed. Female genitalia (Fig. 4.32). Segment IX and X apicolaterally separated; lateral lobes of segment IX (IXd) well developed, tergite IX composed of 3 lobes, anterior lobe (IXa) without setae, posterior lobe (IXb) bearing several setae dorsally and IXc produced as pair of triangular lobes visible beyond segment IX in dorsal aspect, arising from supragenital plate in ventral view, sternum IX with sinuate membranous vulvar scales (e.gon.IX.). Sternum VIII with membranous rectangular vulvar lobe (e.gon.VIII). Supragenital plate (Xe) narrow compared with width of segment IX, sclerotized, posteriorly with rounded apex. Segment X with slightly curved projection produced internally (Xb). Anal opening invisible in ventral view.

Diagnosis. The male and female of this species resemble those of *A. dalecarlica* (Forsslund), but are distinguished from it by the male having a shorter, blunt median process and external branches with more sinuate serration ventromesally; and female having wide segments IX and X, rounded supragenital plate, and more sclerotization and a different shape of the spermathecal sclerite.

Distribution. Northeast Europe; Russia (Siberia, Kamtchatka); Turkestan; Canada; Greenland; Mongolia (Altai Mountains).

Material examined. FINLAND: Lake Kilpisjärvi, 473 meters, 12 July 2002, Jari Ilmonen, 3 females.

Apatania dalecarlica (Forsslund)

Figures 4.6 and 4.33

Apatidea zonella dalecarlica Forsslund 1942: 95 [description as subspecies of *Apatidea zonella* (Zetterstedt), and distribution].

Apatania dalecarlica (Forsslund); Schmid 1954: 32, fig. 69a-c [male genitalia].

Apatelia dalecarlica (Forsslund); Svensson & Tjeder 1975: 269 [elevated to species status: checklist, distribution].

Apatania dalecarlica (Forsslund); Mey 1991b: 357 [Checklist: range extension to East Palearctic Region].

Apatania zonella (Forsslund); Chuluunbat & Morse 2007: 54 [misidentification: checklist, distribution].

Description. Male (n=9), forewing length 6.8 mm, hind wing length 5.5 mm; female (n=33) 7.0 mm, hind wing length 6.0 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.6). Segment IX short dorsally, dorsal process (dpr.) visible in dorsal aspect, ventrolateral part bearing row of many setae near bases of inferior appendages. Inferior appendages semi-cylindrical, each with distal projection (inf.dp.) at apicoventral edge; its harpago short, stout, composed of upper (hpr.ul.) and lower lips (hpr.ll.). Superior appendages short, semi-oval; external branches each bearing lobes ventromesally, bearing several setae on ventral side; single triangular median process

directed ventrad. Body of segment X membranous, fused with median process of segment X, only visible in lateral aspect. Phallicata bearing several short, blade-like bristles on ventral and dorsal sides, endotheca membranous and apically notched dorsoventrally. Parameres (prm.) wide, stout, apices rounded.

Female genitalia (Fig. 4.33). Segment IX and X apicolaterally separated; lateral lobe of segment IX (IXd) well developed, posterior of IX segment composed of middle (IXb) and lower lobes (IXc) bearing many setae and lower part extended as pair of lobes from supragenital plate in ventral view. Sternum IX undeveloped. Sternum VIII with wide, long vulvar lobe (e.gon.VIII). Supragenital plate (Xe) wide compared with width of IX segment, heavily sclerotized, trapezoid. Anal opening invisible ventrally.

Diagnosis. The male and female of this species resembles those of *A. zonella*, but differ from it by the male having a longer median process and external branches bearing less pronounced dentations or lobes ventromesally; and females having narrow segments IX and X, a rectangular supragenital plate (Xe), and less sclerotization and a different shape of the internal spermathecal sclerite (spt.sc.).

Distribution. Scandinavia, Finland, Greenland, Sweden, Norway, Russia (Kamchatka, Kurile Islands), Mongolia (Selenge River Basin).

Material examined. RUSSIA: Kurile Islands: Alaid Island Vladimir Peninsula Stream in Atlasovke, 12 Aug 1997, Russian-USA-Japan Kurile Expedition, Coll #-33; 1 male, 5 females; Determined by T. Arefina as *A. zonella*. FINLAND: Sarmijärvi, 22 Aug 2004, light trap, Coll. J. Itämies; 2 males, 3 females. MONGOLIA: Tov, Gorkhi Terelj National Park, Tuul R. c. 0.5 km upstream of Park Gate bridge, N47.82258,E107.33613, elev 1305

m, 05 Jul 2003, Coll. J. Morse; 1 female. MONGOLIA: Selenge, Bugant/Yaroo, Bar Chuluu Gol, N49.03282,E106.96935, elev 975 m, 17 Jul 2003, Coll. E. Sanaa; 1 female. MONGOLIA: Selenge, Mandal, Aguit Gol, N48.97025,E107.14252, elev 1059 m, 18 Jul 2003, Coll. J. Gelhaus; 2 females. MONGOLIA: Arkhangay Aimag, Bulgan Soum, Urd Tamir Gol braid upstream of bridge ~63 km SW of Tsetserleg, N47.11192,E101.01048, 2066 m, 13-15 Jul 2004, Coll. Selenge River Project (SRP) Team; 7 females. MONGOLIA:Arkhangay Aimag, Ikhtamir Soum, Khoit Tamir Gol ~29 km SW of Ikhtamir, N47.48567,E100.87875, elev. 1749 m, 15 Jul 2004, Coll. SRP Team; 3 females. MONGOLIA:Zavkhan Aimag, Tosontsengel Soum, Gunza Gol ~38 km SW of Tosontsengel, N48.62624,E97.89617, elev. 1831 m, 21-22 Jul 2004, SRP Team; 1 female. MONGOLIA: Hovsgol Aimag, Tumurbulag Soum; Bugcei (Bugceiin) Gol, 45.5 km SW of Moron, N49.26168; E99.88242, Elev. 1618m; 23 Jul 2005, Coll. SRP Team; 7 females. MONGOLIA: Hovsgol Aimag, Renchinlhumbe Soum, Jarin Gol 34 km N of Renchinlhumbe, N51.39835, E99.75013, elev 1577 m, 2 July, 2006, Coll. SRP Team; 6 males, 3 females.

Apatania nikkoensis Tsuda

Figures 4.7 and 4.34

Apatania nikkoensis Tsuda 1939b: 290, pl. 15, figs. 1-5 [adult male genitalia and wings].

Apatania nikkoensis Tsuda; Kobayashi 1983: 49, figs. 2a-e [adult male genitalia].

Apatania kyotoensis Schmid 1954: 21, fig. 55 [misidentification, adult male genitalia].

Apatania nikkoensis Tsuda; Schmid 1955: 82 [checklist].

Description. Male (n=2), forewing length 8.8 mm, hind wing length 7.8 mm; female (n=2), forewing length 9.2 mm, hind wing length 8.0 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.7). Segment IX sharply shortened dorsally, lateral part with distinct linear band of setae, dorsal process visible in lateral view. Inferior appendages stout, cylindrical, each with distal projection ventrolaterally; harpago short, triangular, acutely pointed. Superior appendages fused with external branches, represented by several setae on base; external branches oblong, bearing prominent lobes with setae ventrally; single median process broad, directed ventrad. Body of segment X fused with median process and represented by triangular angle posteriorly with acute point directed anterad. Phallicata deeply notched, bearing short bristles dorsally. Parameres slender with pointed apices.

Female genitalia (Fig. 4.34). Segments IX and X apicolaterally separated; lateral lobes (IXd) well-developed, tergite IX comprising 3 lobes and posterior lobes (IXb and IXc) bearing setae, IXc slightly expanded from supragenital plate, sternum IX with pair of triangular semi-membranous processes (e.gon.IX) connected with lateral lobes (IXd). Sternum VIII with long rectangular vulvar lobe (e.gon.VIII). Supragenital plate (Xe) subtriangular, wide compared to width of segment IX. Anal opening invisible ventrally.

Diagnosis. The male of this species is similar to those of *A. dalecarlica* and *A. zonella*, but differs from them by lacking superior appendages and lacking long bristles on the ventral side of the phallicata. The female of this species is similar to that of *A. zonella*,

but differs from it by having narrow anal opening and very long internal spermathecal sclerite.

Distribution. Japan (Nikko-shi, Tochigi Prefecture).

Material examined. JAPAN: Daiya-gawa River, Nikko-shi, Tochigi Pref., 6 Oct 2002, H. Nishimoto, 2 males, 2 females (in 70% ethanol).

Apatania lenica Ivanov

Figure 4.35

Apatania lenica Ivanov 1991: 48, figs. a-c [adult female genitalia].

Description. From Ivanov & Grigorenko 1991. "Forewing length 7.3 mm, light brown. Female genitalia. Segment IX slender and curved, its lateral lobes long, tergal parts with triangular projection (IXa). Ventral parts (IXd) long slender, slightly curved inwards; vulvar lobe (e.gon.IX.) very long, gradually narrowed at apex. Supragenital plate (Xe) very large, its margins sclerotized, hind edge rounded. Segment X tall from side, with 2 apical tubercules (IXb) on dorsal part and 2 lesser ones (IXc) on lateral parts. The epiproct (Xc) between these tubercules not incised; sides of anus heavily sclerotized."
Male unknown. This species seems to be parthenogenetic.

Female genitalia (Fig. 4.35). Segments IX and X distinct; lateral lobes of IX (IXd) well-developed, tergite IX composed of 2 lobes, posterior one (IXb) with 2 lobes in dorsal aspect; sternite IX with pair of short semi-membranous parts (e.gon.IX) connected with lateral lobes. Sternum VIII with very long, triangular vulvar lobe (e.gon.VIII). Supragenital plate (Xe) wide compared with width of segment IX. Segment X acutely pointed, rectangular in lateral view, 2 ear-shape lobes (IXc) visible on dorsal view.

Diagnosis. The female of this species is similar to that of *A. zonella*, but easily differentiated from it by the rectangular segment IX, long triangular vulvar lobe

(e.gon.VIII.), and the less obvious sclerotization and the different shape of the internal spermathecal sclerite.

Distribution. Russia (East Siberia, Yakutia).

Material examined. None.

Apatania majuscula McLachlan

Figures 4.8, 4.9, 4.36, and 4.37

Apatania majuscula McLachlan 1872: 66, pl. 2, figs. 4-4a [male genitalia].

Apatania majuscula McLachlan; McLachlan 1876: 213, pl. 24, figs [male genitalia].

Apatania majuscula McLachlan; McLachlan 1880: 213, pl. 24, figs. 1-3 [male genitalia].

Apatania majuscula McLachlan; Martynov 1914: 40, figs. 27-32 [adult male and female genitalia].

Apatelia majuscula (McLachlan); Martynov 1917: 61 [distribution].

Apatania majuscula McLachlan; Schmid 1954: 28, figs. 64-65 [adult male and female genitalia].

Apatania döhleri Schmid 1954: 29, fig. 66 [male genitalia]; NEW SYNONYM.

Apatania majuscula McLachlan; Schmid 1955: 82 [checklist].

Apatania döhleri Schmid; Schmid 1955: 82 [checklist].

Apatania majuscula McLachlan; Lepneva 1971: 162-166, figs. 214-219 [larval description].

Apatania majuscula McLachlan; Mey & Dulmaa 1985: 92, figs. 12-13 [checklist, distribution, female genitalia].

Apatania döhleri Schmid; Mey & Dulmaa 1985: 92, figs. 14-15 [checklist, distribution, female genitalia].

Apatania majuscula McLachlan; Mey 1991b: 356 [checklist, distribution].

Apatania majuscula McLachlan; Chuluunbat & Morse 2007: 54 [checklist, distribution].

Apatania doehleri Schmid; Chuluunbat & Morse 2007: 54 [checklist, distribution].

Apatania majuscula McLachlan; Ivanov & Melnitsky 2007: 33 [distribution].

Apatania doehleri Schmid; Ivanov & Melnitsky 2007: 33 [distribution].

Description. Male (n=26), forewing length 8.6 mm, hind wing length 6.9 mm; female (n=18), forewing length 8.8 mm, hind wing length 7.0 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.7). Segment IX strongly narrowed dorsally, dorsal process visible in lateral view. Inferior appendages semi-cylindrical, each with distal projection at posteroventral edge; its harpago short, triangular, composed of upper and lower lips, visible in dorsal aspect. Superior appendages moderate elongated; external branches long, slender, each with ventral margin bearing setae at and near apex; single median process strongly gradually curved ventrad, apex pointed with minute spines subapicolaterally. Body of segment X sclerotized, triangular, fused with external branches and median process. Phallicata semi-membranous, bearing pair of rows of blade-like setae ventrally, gonopore with small spines. Parameres stout, subapical inner surfaces with minute dentations.

Female genitalia (Fig. 4.36). Segment IX and X separated apicolaterally; lateral lobes of segment IX (IXd) well-developed; tergite of segment IX with 3 lobes, posterior lobes

(IXb and IXc) bearing numerous long hairs, lobe IXc posterior edge notched; sternum IX with 2 triangular vulvar scales (e.gon.IX) connected with lateral lobes. Sternum VIII with semi-rectangular moderate-sized vulval lobe (e.gon.VIII). Supragenital plate (Xe) sclerotized, triangular, its posterior apex rounded. Segment X (Xb) without setae, triangular visible in lateral view. Anal opening (an.) visible ventrally.

Apatania doehleri was described by Schmid (1954) as follows (translated from French):

> "Species of intermediate size (scale 17 mm). Front wing with rather strong sexual dimorphism, f3 petiolate. Hind wing f3 also petiolate; M3 + 4 and Cu1 connected with small stalk.
> "Male genitalia: Segment IX narrow dorsally. Superior appendages very slender and relatively long. External branches also very slender and widened apically. Median process as long as external branches and strongly bent ventrad. Inferior appendages subcylindrical and not thickened apically; each with its apical part very long and rather narrow. Dorsal part of appendage [harpago] elongated, as long as apical part of basal appendage. Phallic apparatus extreme, apical point soft, truncated, each edge of truncation bearing line of ventral spines. Gonopore cup with tiny spines."
> "This species is known only from the type, from Tunkun (Sajan) and deposited in the Döhler collection."

According to Schmid's description and illustrations, the male of *A. doehleri* differs from that of *A. majuscula* by having longer superior appendages and median process, and gonopore with smaller spines. I found that several specimens from different populations show slight differences in the shape of superior appendages and median process. The female of presumed *A. doehleri* was reported from Mongolia by Mey and Dulmaa (1985) and their illustrations show the same structures illustrated in Schmid's description of the *A. majuscula* female. Therefore, *A. doehleri* and *A. majuscula* probably are the same species and are here synonymized.

Diagnosis. The male of this species resembles that of *A. dalecarlica* in the thick parameres, but differs from that species and all others in the *A. zonella* Group by the much longer and more slender external branches and median process of tergum X.

Distribution. Russia (Padunsk, Irkutsk, northern Russia, Siberia, Siberian-Sajan Mountains); Mongolia (Selenge River Basin).

Material examined. MONGOLIA: Selenge, Mandal, Boyant Gol (trib. of Tunkhel Gol) 13.8 km above town of Tunkhel, 2.0 km upstream of Shonkhor Camp, N48.67237,E106.87851 elev 1078 m, 16 Jul 2003, Coll. SRP Team; 2 males, 3 females. MONGOLIA: Tov, Erdene, Yestii hot spring, Gorkhi Terelj National Park, N 48. 60223, E 107.84171, elev. 1444m, 28-29 Jul 2003, Coll: B. Hayford; 1 male, 7 females. MONGOLIA: Tov, Erdene, Yestii hot spring, Gorkhi Terelj National Park, N48.42080, E107.91406, elev. 1818m, 28 July 2003, Coll: J. Morse, S. Chuluunbat, Y. Oyunchuluun; 15 females. MONGOLIA: Ovorhangay Aimag, Bat-Olziy Soum, braid of Orkhon Gol ~40 km W of Khujirt, N46.88586,E102.34386, elev 1646 m, 06-07 Jul 2004, Coll. SRP Team; 1 male. MONGOLIA: Ovorhangay Aimag, Bat-Olziy Soum, Orkhon's Waterfall on Ulaan Gol ~300 m S of Orkhon Gol, ~84 km W of Khujirt, N46.78742,E101.96021, elev 1809 m, 07 Jul 2004, Coll. SRP Team; 1 male, 5 females. MONGOLIA: Arkhangay Aimag, Bulgan Soum, Urd Tamir Gol ~38 km SW of Tsetserleg, N47.28244, E101.18793, elev. 1872 m, 12-13 Jul 2004, Coll.SRP Team; 3 males, 6 females. MONGOLIA: Arkhangay Aimag, Bulgan Soum, Urd Tamir Gol braid upstream of bridge, ~63 km SW of Tsetserleg, N47.11192,E101.01048, 2066 m, 13-15 Jul 2004, Coll. SRP Team, malaise trap; 20 males, 86 females. MONGOLIA: Zavkhan Aimag, Ider

Soum, Ideriin Gol ~4 km NE of Zuunmod/Ider, N48.24995,E97.40627, elev. 1929 m, 22-23 Jul 2004, SRP Team; 8 males, 25 females. MONGOLIA: Zavkhan Aimag, Ider Soum, Dogshin/Nogoon Nuur ~21 km SE of Zuunmod/Ider, N48.06257,E97.55064, elev. 2054 m, 23-24 Jul 2004, Coll.SRP Team; 10 males, 17 females. MONGOLIA: Hovsgol Aimag, Tumurbulag Soum; Bugcei (Bugceiin) Gol 45.5 km SW of Moron, N49.26168; E99.88242, elev. 1618m; 23 Jul 2005, Coll. SRP Team; 17 males, 10 females. MONGOLIA: Hovsgol Aimag, Ulaan-Uul Soum, Bagtagin Gol 15 km NNE Ulaan-Uul, N50.80484, E99.32228, elev 1598 m, 29 Jun 2006, Coll. SRP Team; 17 males, 14 females. MONGOLIA: Hovsgol Aimag, Renchinlhumbe Soum, Soyo Brigade springs and Ikh Turuugin Gol, 35 km N of Ulaan-Uul, N50.99269, E99.35406, elev 1549 m, 30 Jun 2006, Coll. SRP Team, malaise trap; 3 males, 5 females. MONGOLIA: Bulgan Aimag, Khyalgant Soum; Baruun Burkhiin Gol, 36.56 km NNW of Hangal, N49.62431; E104.24514, elev. 1015m; 7-8 Jul 2005, Coll. SRP Team; 1 male.

Apatania mongolica Martynov

Figure 4.10

Apatania mongolica Martynov 1914: 44, figs. 33-36 [male genitalia].

Apatelia mongolica (Martynov); Martynov 1917: 61 [distribution].

Apatania mongolica Martynov; Ulmer 1932: 68 [checklist].

Apatania mongolica Martynov; Schmid 1954: 40, fig. 75 [male genitalia].

Apatania mongolica Martynov; Schmid 1955: 83 [checklist].

Description. Translated from German, Martynov 1914.

> "Male genitalia. Segment IX not broad, from ventral view strongly narrowed; preanal appendages small. Middle fused part of segment X as with *A. majuscula,* with basal region in lateral view rather broad, then suddenly curved downward and tapered; external branches of segment X long; lower part of segment X (ring) forming posteriorly no special appendages (as with *A. majuscula*). Basal part of each inferior appendage dark-brown, slender basally and somewhat extended, truncate apically and without special projections; the narrow basic components of both parts form down, rather thin projections/leads, where they collide are arranged. Second part of inferior appendages [harpago] not largely yellow, posteriorly deeply excised divided into slender, long upper process and short, broad lower process. Phallus relatively slender, apically divided into 2 processes carrying some rows of bristles. From internal side of central shaft of phallus extend 2pairs of processes in shape of 2 long narrow brown plates, with 1 pair forming small extension on each internal sides subapically; second pair represented by 2 long, thick, but soft appendages."

Male genitalia (Fig. 4.10). Segment IX extremely short ventrally. Inferior appendages cylindrical, narrowed mesally, each with distal projection posteroventrally; its harpago short, acutely pointed ventromesad. Superior appendage small, cylindrical; external branches long, slender, 3 times longer than superior appendages; median process shorter than external branches, its base broad, apex slender, strongly curved ventrad. Body of segment X thumb-like process arising from base of appendages. Phallicata bearing numerous bristles on its inner side. Parameres obliquely truncated at apex.

Female unknown.

Diagnosis. The male is similar to that of *A. majuscula,* but differs from it by having a very broad median process curved ventrad, C-shaped.

Distribution. China (Alaschan, Chyn-juan).

Material examined. None.

Apatania sachalinensis Martynov

Figure 4.38

Apatania sachalinensis Martynov 1914: 48, figs. 37-39 [female genitalia].

Apatania sachalinensis Martynov; Schmid 1953: 163, fig. 32 [female genitalia].

Apatania sachalinensis Martynov; Schmid 1955: 81 [checklist].

Description. Female (n=4), forewing length 7.2 mm, hind wing length 5.8 mm. Wing venation typical for the genus.

Male unknown.

Female genitalia (Fig. 4.38). Segments IX and X distinct posteriorly; lateral lobes of segment IX (IXd) well developed with less incision of posterior margin, posterior of segment IX divided into 2 lobes (IXb and IXc), sternum e.gon.IX undeveloped. Sternum VIII with pointed apex of long striated vulvar lobe (e.gon.VIII.). Supragenital plate (Xe) wide compared to width of IX segment, sclerotized, posteriorly rounded. Segment X (Xb) extended into finger like processes. Anal opening invisible ventrally.

Diagnosis. This species differs from other congeners by having segment X (Xb) a finger-like lobe extended ventrolaterad with 2 small lobes behind supragenital plate, extensive internal sclerotization and very long internal spermathecal sclerite.

Distribution. Russia (North Sachalin, Khabarovskii Krai).

Material examined. RUSSIA: Khabarovskii Krai, Nikolaevskii region, Iski River, 4-5 km upper mouth, 28 June 2000, Coll. T.M. Tiunova, Coll #-H.16; 4 females.

Apatania copiosa Group

Synopsis of characters. Male genitalia with long external branches (synapomorphy 12), and apex with single spine or many bristles (synapomorphy 13); harpago short (synapomorphy 5). This group contains 6 species.

Apatania copiosa (McLachlan)

Figures 4.11 and 4.39

Apatidea copiosa McLachlan 1875: 29, pl. 2, figs. 4-4c [adult male and female genitalia, front and hind wings].

Apatidea copiosa McLachlan; McLachlan 1880: 218, pl. 24, figs. 1-5 [redescription: adult male and female genitalia, and front and hind wings].

Apatidea copiosa McLachlan; Martynov 1914: 6 [bibliography].

Apatelia copiosa McLachlan; Martynov 1928: 475, pl. 23, figs. 1-2 [distribution, female genitalia].

Apatidea copiosa McLachlan; Schmid 1950: 53, figs. 13-16 [male genitalia].

Apatania copiosa (McLachlan); Schmid 1954: 45, fig. 79, 80 [male and female genitalia].

Apatania copiosa (McLachlan); Schmid 1955: 83 [checklist].

Apatania copiosa (McLachlan); Schmid 1963: 441, figs. 15-17 [male genitalia].

Apatania copiosa (McLachlan); Lepneva 1971: 167-171, figs. 220-227 [larval description].

Apatania grandimera Ivanov 1991: 46, figs. 1a-f [adult male and female genitalia]; synonymized by Mey 1993.

Apatania copiosa (McLachlan); Malicky 2005: 565 [distribution, range extension to WP].

Description. From McLachlan 1880. "Male genitalia. IX segment dorsally slightly produced, rounded on its edge. Superior appendages extremely long, viewed from above they are nearly parallel, the tips turned inward and downward, and somewhat serrate, acute. The intermediate appendage start from within the base of each superior appendage, very slender and nearly straight, slightly hairy, tips suddenly dilated and obtuse; between them is median process, which is turned downward, slightly hairy on edge. Inferior appendages large very hairy, convex externally, short, obsoletely 2-jointed, second joint being turned in and very obtuse, between them ventrally 2 widened divergent spiniform processes. Female genitalia. IX segment rather dilated above, but gradually narrowed laterally; the IX ventral segment forming a curved process on each side. The vulvar scale has very long middle lobe which project between the lateral portion of IX segment."

Male genitalia (Fig. 4.11). Segment IX longest anterolaterally and bearing row of long setae posterolaterally, dorsal process (dpr.) rectangular in lateral aspect, acutely pointed posterad. Inferior appendages stout, broadest at base; each with harpago short, stout, rectangular in lateral view, triangular in dorsal view. Superior appendages very long, cylindrical; external branches long, cylindrical, bearing bristles along their ventral edges, with most bristles apical; single, long, slender median process with fine setae along lateral edges; internal branches fused with external branches, each forming slight lobe at base of its external branch. Body of segment X membranous, depressed dorsoventrally and broadly rounded apically. Phallicata with many blade-like bristles laterally; endotheca with short bristles. Parameres pointed apically, curved laterad.

Female genitalia (Fig. 4.39). Segments IX and X distinct posterolaterally; lateral lobes (IXd) slightly developed, posterior of segment IX with 2 lobes (IXb and IXc) bearing several setae. Segment X (Xe) pointed sharply posteriorly. Vulvar lobe (e.gon.VIII) triangular in lateral aspect.

Diagnosis. The male of this species is similar to that of *A. hamardabanica* Mey, but it differs from it in having long superior appendages and median process, and in the distinct shape of the harpago and phallicata.

Distribution. Turkestan; Russia (Shakhimardana watershed, its rivers in the Kokanskom region).

Material examined. None.

Apatania hamardabanica Mey

Figures 4.12 and 4.40

Apatania hamardabanica Mey 1994: 302, figs. 13-18 [male and female genitalia].

Description. Male (n=2), forewing length 8.6 mm, hind wing length 7.5 mm; female (n=1), forewing length 10.1 mm, hind wing length 8.2 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.12). Segment IX longest laterally, mesoposterior edge bearing tuft of long setae, dorsal process visible laterally. Inferior appendages slightly narrowed apically; each with its harpago short, apically very slender and curved mesad. Superior appendages moderately long, directed posteromesad; external branches stout, very long, more than twice as long as superior appendages, ventral edges of external branches bearing long setae, especially dense apically; internal branches shorter than superior appendages, connected with bases of external branches and sharply pointed; single median process about as long as superior appendages, bearing tuft of setae apically. Body of segment X membranous, composed of pair of subtriangular structures. Phallicata

apical edges with several spines, and gonopore with few minute spines. Parameres long, slender, apically pointed, curved mesad, inner edges serrated.

Female genitalia (Fig. 4.40). Segments IX and X divided posterolaterally; lateral lobes of IX (IXd) not developed, tergite IX composed of 3 lobes (IXa, IXb and IXc), posterior parts (IXb and IXc) bearing many long setae; sternum IX with 2 subtriangular vulvar scales (e.gon.IX.). Sternum VIII with short rectangular vulvar lobe (e.gon.VIII.). Supragenital plate (Xe) semi-oval, posterior edge irregularly heavily sclerotized. Apex of segment X (Xb) without setae and less sclerotized visible in ventral view. Anal opening visible ventrally.

Diagnosis. The male of this species is similar to that of *A. copiosa*, but is easily distinguished by having shorter superior appendages, 2 lobes of membranous body of segment X, apically narrowed and curved harpago, and the shape of the phallicata and the parameres.

Distribution. Russia (Siberia, Hamardaban Mountains).

Material examined. Paratypes: Siberien, Hamardaban-Geb. Meteorolog. Stat., 9 Jun- 13 Jun 1993, Coll. W.Mey; 2 males, 1 female.

Apatania sinensis Martynov

Figures 4.13 and 4.41

Apatania sinensis Martynov 1914: 86, figs. 1-3 [adult female genitalia].

Apatania sinensis Martynov; Martynov 1917: 61 [distribution].

Apatania sinensis Martynov; Martynov 1935: 314, figs. 127-129 [adult male genitalia].

Apatania sinensis Martynov; Schmid 1954: 46, figs. 81-82 [adult male and female genitalia].

Apatania sinensis Martynov; Schmid 1955: 83 [checklist].

Description. Male (n=10), forewing length 8.5 mm, hind wing length 7.0 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.13). Segment IX much longer anterolaterally, 2 row of long setae along the posterior margin of segment, 1 row in middle, another row close to bases of inferior appendages, dorsal process visible in lateral view. Inferior appendages cylindrical slightly widened apically; each with its harpago short, stout, broad at base. Superior appendages moderately long, cylindrical; external branches long, compressed laterally, apically wide, bearing 2 tufts of short bristles, dorsal tuft with 3 slightly longer bristles, other tuft with numerous short bristles arranged along inner margin of apex; internal branches fused with median process. Median process long, slightly shorter than external branches, compressed, slender in dorsal view, broad in lateral view, bearing minute spines apically. Body of segment X small, cylindrical process arising from base of each external branch, visible in lateral view. Phallicata bearing numerous long bristles ventrally, and several long bristles apically. Parameres stout, depressed dorsoventrally, broad at base apically narrowed, curved laterad, apical inner margin with small serrations.

Female genitalia (Fig. 4.41). Segments IX and X divided apicolaterally; lateral lobe of segment IX (IXd) moderatelly developed, tergite IX (IXa, IXb, IXc) comprising broad rectangular plate, apex of segment IXc divided into 2 subrectangular processes, visible in

ventral aspect. Sternum VIII with vulvar lobe (e.gon.VIII.), long, rounded. Supragenital plate (Xe) broad, rectangular. Anal opening invisible ventrally.

Diagnosis. The male of this species differs from that of other congeners by having well-developed external branches with bristles apically; broad, compressed parameres; and a phallicata with numerous long bristles.

Distribution. China (Chanjan, Maiche); Russia (Primorskii Krai).

Material examined. RUSSIA: Primorskii Krai, Khasan District, Sukhanovskii Pereval, 8 Sept 1998, Coll. V. Lubaretz; 10 males.

Apatania ulmeri Schmid

Figure 4.14

Apatania ulmeri Schmid 1950: 54, figs. 9-12 [adult male genitalia].

Apatania ulmeri Schmid; Schmid 1954: 42, fig. 76 [adult male genitalia].

Apatania ulmeri Schmid; Schmid 1955: 83 [checklist].

Description. Translated from French, Schmid 1950. "Male Genitalia: IX rather broad laterally, a little narrower dorsally and ventrally. Superior appendages small and lengthened, approximately 3 times longer than broad. Appendages of X segment very long, cylindrical, bent with right angle ventromesad to the apex; their end rather blunt and is finished by a small conical tooth embedded in a notch of the appendix; they do not carry spines like those of *A. copiosa*, but their internal edge is provided in the middle of its length with a small appendage armed with some hairs. X dorsal segment is much thicker than that of *A. copiosa*; its side angles are concave; its plate rather long and thin ventrally; the basal part is larger rather regular; the apical part is short and triangular. Phallic apparatus very well-developed and of extremely curious form. The penis is a very large body, formed of 3 parts: a median part, chitinous and finished by an oval concavity; at the basal end of this concavity emerges the ejaculatory channel; the apical half is nonchitinous and carries on its ventral face 2 small lines of short thickened spines; the 2 membranous side parts of the penis are completely folded, ending apically in a long cylindrical appendage covered with long spines. Also large chitinous

parameres flattened and broad at the base, tapered and bent regularly mesad apically."

Male genitalia (Fig. 4.14). Segment IX longer anterolaterally, row of setae at posterolateral edge, dorsal process visible in lateral view. Inferior appendages long, broad at base; harpago short, triangular. Superior appendages moderately long, cylindrical; external branches long and wide, apically strongly curved ventrolaterad with short thick spine at tip, mesally with small setose projection about 1/3rd distance from base; single median process slightly longer than superior appendages, pointed posteroventrad. Segment X fused with external branch, represented by slight, posteriorly elevated protuberance. Phallicata comprising pair of membranous projections bearing many short bristles with sclerotized part above it, gonopore with few minute spines. Parameres apically pointed, directed mesad.

Female unknown.

Diagnosis. The male of this species is similar to those of *A. maritima* and *A. sarkandensis*, but differs from them by having a ventromesal projection on each external branch, and a membranous pair of setose projections only at the apical part of the phallicata.

Distribution. China (Sajan)

Material examined. None.

Apatania maritima Ivanov

Figures 4.15 and 4.42

Apatania maritima Ivanov 1993: 15, figs. 1-9 [adult male and female genitalia].

Description. Male (n=1), forewing length 8.4 mm, hind wing length 6.8 mm; female (n=1), forewing length 9.2 mm, hind wing length 7.8 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.15). Segment IX longer anterolaterally, posteriorly bearing row of long setae, dorsal process visible in lateral view. Inferior appendages short, stout, very wide at base; harpago short, stout, rounded. Superior appendages moderate cylindrical, straight; external branches long and wide, strongly curved ventromesad subapically, with short black spine at apex of each; single median process pointed posteroventrad, bearing few setae apically, obliquely truncated in lateral view. Body of segment X composed of 2 triangular protuberances. Phallus composed of pair of long membranous projections bearing numerous long bristles and sclerotized phallicata with few short spines at apex, gonopore with few minute spines directed dorsad. Parameres long, slender, acute in lateral aspect, rounded apically in dorsal and ventral aspects.

Female genitalia (Fig. 4.42). Segments IX and X divided; lateral lobe of segment IX (IXd) moderately developed, tergite IX comprising 3 slightly fused lobes (IXa, IXb and IXc); sternum IX with 2 triangular semi-membranous projections (e.gon.IX.). Sternum VIII with short vulvar lobe (e.gon.VIII.) with rounded apex. Supragenital plate (Xe) narrow compared to width of segment IX, sclerotized, trapezoid. Segment X (Xb) slightly projected posteriorly. Anal opening visible ventrally.

Diagnosis. The male of this species is similar to that of *A. ulmeri* and *A. sarkandensis* Ivanov, but differs from them in having a phallus with long membranous projections with numerous long bristles.

Distribution. Russia (South Primorje, Vicinity of Slavyanka)

Material examined. RUSSIA: Primorsii Krai, Kedrovaya Pad Nature Reserve, Kedrovaya River, 13 June 2003, Coll. T.M. Tiunova; 1 male, 1 female.

Apatania sarkandensis Ivanov

Figures 4.16 and 4.43

Apatania sarkandensis Ivanov 1991: 6, figs. 3a-h [adult male and female genitalia].

Description. From Ivanov 1991. "Forewing 5.0 mm. Male genitalia. Dorsal part of segment IX has parallel margins, ventral part slender, lateral part near hind margins with separate plate covered by long hairs. Basal segment of inferior appendages broad and directed dorsad; apical segment acute at the apex and turned mediodorsad. Preanal appendages wedge-like viewed from above and curved downward in lateral view. External branches long, flat, very slender and curved ventromedially at their ends; the apex of each one provided with 1-3 short black setae. Segment X strongly inclined ventrad, with nearly parallel lateral margins and slender raised apex. Aedeagus short, its tip bearing vertical divided lobes; apical part of aedeagus broad, its upper surface incised, lower surface provided with small tuberculus. Parameres long slender, curved inwards (Fig. 4.16)."

Female genitalia (Fig. 4.43). Segments IX and X distinct; lateral lobe (IXd.) moderately developed, tergite IX terminating in pair of lobes (IXb.), each with dark subapical patch, sternum IX with 2 rounded vulvar scales (e.gon.IX.). Sternum VIII with acutely pointed, broad vulvar lobe (e.gon.VIII.). Supragenital plate (Xe.) narrow compared with width of segment IX, rounded posteriorly. Anal opening invisible ventrally.

Diagnosis. The male of this species is similar to those of *A. ulmeri* and *A. maritima*, but is readily differentiated from them by lacking bristles or setae on the membranous parts of the phallicata. The female of this species is easily differentiated from other congeners by having a pair of dark patches near the posterior end of tergite IX.

Distribution. Kazakhstan (Sarkand region).

Material examined. None.

Apatania chokaiensis Group

Synopsis of characters. Male genitalia with apically bifurcated single median process (synapomorphy 17); harpago short (synapomorphy 5); superior appendages small (phylogenetically equivocal); phallicata with long bristles (phylogenetically equivocal). This group contains 2 species.

Apatania chokaiensis Kobayashi

Figures 4.17 and 4.44

Apatania chokaiensis Kobayashi 1973: 33, pl. 7 [adult male genitalia, and wing]

Description. Male (n=2), forewing length 9.8 mm, hind wing length 8.6 mm; female (n=1), forewing length 9.0 mm, hind wing length 8.2 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.17). Segment IX short, with row of setae at base of each inferior appendage, single long seta at either side of dorsal process. Inferior appendages cylindrical, bearing many setae; each with base of harpago wide, stout, slightly curved

mesad. Superior appendages small, triangular dorsally; external branches compressed laterally, wide and triangular in lateral aspect; single median process fused with internal branches of segment X, bifurcate at apex. Body of segment X (bo.X.) heavily sclerotized, apical edge pointed posteromesad, deeply emarginated medially. Phallus with phallicata (phls.) deeply notched apically and forming pair of long processes surrounded by several long bristles ventrolaterally; minute setae at median groove and primary gonopore. Parameres (prm.) stout, each obliquely truncate apically with serrations on mesal angles.

Female genitalia (Fig. 4.44). Segments IX and X clearly divided posterolaterally; lateral lobe of IX (IXd) not developed, posterior of IX (IXb, IXc) divided into 2 lobes; sternum IX with small triangular membranous vulvar scale (e.gon.IX.). Sternum VIII with rectangular apex of vulvar lobe (e.gon.VIII.). Supragenital plate (Xe.) narrow, sclerotized. Apex of segment X (Xc.) slightly extended into small triangular process in lateral view, visible dorsally. Anal opening invisible ventrally.

Diagnosis. The male of this species resembles that of *A. ishikawai* Schmid, but differs from it by having long bristles at the apex of the lateral processes of the phallicata and an obliquely truncate apical edge of each paramere.

Distribution. Japan (Akita and Yamagata Prefectures).

Material examined. JAPAN: Gassan-Yusui spring stream, Nishikawa-cho, Nishimurayama-gun, Yamagata Pref., collected as pupae 7 Oct 2005, and emerged 10-22 Oct 2005, H. Nishimoto; 2 males, 1 female (in 70% ethanol).

Apatania ishikawai Schmid

Figures 4.18 and 4.45

Apatania ishikawai Schmid 1964: 832, figs. 25-27 [male genitalia].

Apatania ishikawai Schmid; Kobayashi 1983: 51, figs. a-c [male genitalia].

Description. Male (n=3), forewing length 9.0 mm, hind wing length 8.0 mm; female (n=3), forewing length 8.8 mm, hind wing length 8.0 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.18). Segment IX short posterolaterally at bases of inferior appendages. Inferior appendages cylindrical, bearing many setae, each with basodorsal part elevated as triangular lobe in lateral view; base of each harpago wide, curved mesad from mid length. Superior appendages small, oval dorsally; external branches triangular in lateral aspect; single median process fused with internal branches, bifurcate apically. Body of segment X sclerotized along the edge, with median emargination. Phallicata deeply notched apically to form pair of laterally acute processes bearing several long bristles ventrally, minute spines dorsally at gonopore. Parameres somewhat depressed, apically curved mesad.

Female genitalia (Fig. 4.45). Segments IX and X divided posterolaterally; lateral lobe of segment IX (IXd.) undeveloped, tergite IX terminated by 2 setose lobes (IXb.); sternum IX with acute membranous vulvar scales (e.gon.IX.) along edges of lateral parts. Sternum VIII with long rectangular apex of vulvar lobe (e.gon.VIII.). Supragenital plate (Xe.) wide compared with width of segment IX, sclerotized. Segment X (Xc.) small, slightly

emarginated posteriorly, visible in dorsal and ventral aspects. Anal opening invisible ventrally.

Diagnosis. The male of this species resembles that of *A. chokaiensis*, but is distinguished by having long bristles only on the ventral side of the phallicata and having parameres straight and apically pointed, without any mesal lobes or serrations.

Distribution. Japan (Ishikawa Prefecture).

Material examined. JAPAN: Yoshinodani-mura, Ishikawa-gun, Ishikawa Pref., 16 Oct 1985, H. Nishimoto; 3 males, 3 females (in 70% ethanol).

Apatania parvula Group

Synopsis of characters. Male genitalia with short harpago (synapomorphy 5), and harpago apically strongly curved and directed ventrad (synapomorphy 18); tuft of short hair present at posterolateral edge of inferior appendage (synapomorphy 19); superior appendages small (phylogenetically equivocal), segment IX extremely narrow dorsally (phylogenetically equivocal). This group contains 2 species.

Apatania parvula Martynov

Figures 4.19, 4.20 and 4.46

Apatania parvula Martynov 1935: 318, figs. 130-135 [adult male and female genitalia].

Apatania parvula Martynov; Schmid 1953: 166, figs. 34-35 [adult male and female genitalia].

Apatania crassa Schmid 1953: 166, fig 33 [male genitalia]; NEW SYNONYM.

Apatania crassa Schmid; Schmid 1955: 81 [checklist].

Apatania parvula Martynov; Schmid 1955: 81 [checklist].

Apatania crassa Schmid; Kobayashi 1983: 50, figs. 3a-e [male genitalia].

Description. Male (n=8), forewing length 7.0 mm, hind wing length 6.2 mm; female (n=4), forewing length 8.0 mm, hind wing length 7.0 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.19). Segment IX significantly narrowed dorsally, widened laterally. Inferior appendage with tuft of fine short setae on posterolateral margin; harpago acutely pointed apically, curved ventrad. Superior appendages small cylindrical; external branches slender as long as median process, widened at the apex bearing several setae; median process slender, acutely pointed, directed ventrad. Body of segment X with a pair of sclerotized tubular structures connected by mesal membrane, sclerites with denticles on posterolateral edges. Phallicata sclerotized, emarginated apically in lateral view. Parameres straight, with pointed apices.

Female genitalia (Fig. 4.46). Segment IX and X laterally separated; lateral lobe (IXd) slightly developed connected with wing-like projection, posterior of segment IX comprising with 2 lobes (IXb and IXc), posterior one slightly cover segment X (Xc). Sternum IX with semi-trapezoid membranous vulvar scales (e.gon.IX) connected with lateral lobes (IXd). Sternum VIII with short rectangular vulvar lobe (e.gon.VIII). Supragenital plate (Xe) sclerotized, flower shaped, narrow compared to width of IX segment. Segment X (Xc) extended from segment IX trapezoid shaped. Anal opening invisible ventrally.

Apatania crassa was described by Schmid (1953) as follows (translated from French):

> "Male Genitalia: IX segment fairly broad laterally. Superior appendages very small and blunt. Lobe of IX segment in long regular and narrow band; its longer than that of *A. parvula* and strongly bent downwards. External branches of X segment longer than those of *A. parvula*, but of identical form; very thin at the base and are strongly thickened with the apex. There are vestiges, quite visible internal branches. Body of segment X definitely shorter than the appendages; to the apex it carries 2 broad concavities; the external edge is almost completely pectinate and begin with a blunt point carrying a transverse transparent membrane. Lower appendages very large and thick; the basal part is very bulky and carries at its base of the internal coast a strong wing supporting the phallic apparatus; the final part is short and very thick; it reaches 1/3 of the basal part length and ends in a strong tooth directed downwards and preceded by a deep notch. Penis less strongly flattened with the apex than that of *A. parvula* it ends in 2 small wings bent forwards; its higher edge carries 2 vertical peaks rather largely isolated. Paramere as long as the penis and ending in a weak hook."

According to Schmid's description and illustrations, the male of *A.crassa* slightly differs from that of *A. parvula* by having smaller superior appendages and strongly bent median process. Levanidova (1979) illustrated slight differences in the appendages of X segment and also in dentation at apices of body of X segment from different populations of *A. parvula*. The female of *A. crassa* is unknown. Therefore, *A. crassa* and *A. parvula* probably are the same species and are here synonymized.

Diagnosis. The male and female of this species resembles *A. insularis*, but the male is easily distinguished from it by having body of segment X with rectangular dentate apices; and the female differs from it in having invisible anal opening, and different sclerotization and shape of internal spermathecal sclerite.

Distribution. Russia (Kurile Islands, Far East Russia); Japan (Hokkaido Prefecture, Sapporo).

Material examined. JAPAN: Lake Shikotsu, Okutan, Chitose-shi, Hokkaido Pref., 6 Oct 1999, H. Nishimoto, 3 males, 3 females (in 70% ethanol). RUSSIA: Kurile Islands, Ketoi

Island, Ke-95-VAT-47, 19 Aug 1995, Russian-USA-Japan Kurile Expedition, Coll #-47; 5 males, 1 female.

Apatania insularis Levanidova

Figures 4.21 and 4.47

Apatania insularis Levanidova 1979: 70, figs. 1-4 [adult male and female genitalia].

Description. Translated from Russian (Levanidova 1979):

> "Body length 7.5mm, wing length 19-20mm (along the left to right wings). Body dark brown, wings yellow brownish. Front wing similar to that of *A. parvula*, dark spots present at R1 and R2, both sexes f3 has little stalks, M3+4 and Cu1 connects without stalk. Male genitalia: Segment IX extremely narrowed dorsally, and widened laterally and ventrally. Preanal appendages small, oval. Internal parts reduced portion of *A. crassa*. Body of segment X long sclrotized part apically narrowed and elongated. Membranous part at its base and connects with segment IX, external branches long slender, median process long slender curved ventrad. Basal part of inferior appendage wide, tuft of setae on posterolateral angle; apical part of it pointed curved ventrad. Aedeagus long, apical part divided into 2 lobes, parameres long dark. Female genitalia: Segment IX and X dorsally connected, similar to *A. parvula*, lateral-ventral part chitinous. Supragenital plate short. Segment X long, tube-like shape dorsal part long and ventral part short. Anal opening heavily sclerotized."

Male genitalia (Fig. 4.21). External branches elongate somewhat clavate at apices. Median process twice shorter than external branches, slender curved ventrad. Base of inferior appendage enlarged; harpago apically pointed curved ventrolaterad. Body of segment X composed of a pair of heavily sclerotized slender processes apically curved dorsoventrad, about same length as median process. Phallicata simple structure slightly dilated apically. Parameres slender, straight, pointed apically.

Female genitalia (Fig. 4.47). Segment IX and X laterally separated; lateral lobe of IX (IXd) slightly developed, continued like wing-like projection; posterior of segment IX

composed of 2 lobes (IXb and IXc), posterior part produced acutely pointed triangular process (IXc). Sternum IX without vulvar scale (e.gon.IX). Sternum VIII with short small, semi-oval vulvar lobe (e.gon.VIII). Supragenital plate (Xe) small, truncated posteriorly formed 2 small lobes, visible in ventral aspect. Segment X (Xc) long trapezoid with shallow excision posteriorly. Anal opening visible ventrally.

Diagnosis. The male of this species is similar to *A. crassa* and *A. parvula*, but differs from them by having body of segment X with a pair of slender, apically pointed processes; and the female of this species similar to *A. parvula*, but differs from it in having visible anal opening, different sclerotization and shape of internal spermathecal sclerite.

Distribution. Japan (Hokkaido); Russia (Kurile Islands).

Material examined. None.

Apatania stigmatella Group

Synopsis of characters. Male genitalia with short harpago (synapomorphy 5), and inner side of harpago with numerous long hairs (synapomorphy 20); short external branches with broad subtriangular apices (synapomorphy 21); median process composed of a pair of process (phylogenetically equivocal). This group contains 2 species.

Apatania stigmatella (Zetterstedt)

Figures 4.22 and 4.48

Phryganea stigmatella (Zetterstedt) 1840: 1066 [description].

Apatania pallida Hagen 1861: 270 [Synonym according to Milne, 1935: 49; description and distribution].

Apatania frigida McLachlan 1867: 57 [Synonym according to Milne, 1935: 49; species description and distribution].

Apatania stigmatella (Zetterstedt); McLachlan 1880: 213, pl. 23, figs. 1-3 [male genitalia].

Apatania stigmatella (Zetterstedt); Wallengren 1886: 77 [redescription].

Apatania stigmatella (Zetterstedt); Morton 1902: 155, figs. 4-6 [female genitalia].

Apatania stigmatella (Zetterstedt); Martynov 1914: 30, figs. 7-11 [male and female genitalia].

Apatania stigmatella (Zetterstedt); Martynov 1917: 61 [distribution].

Parapatania stigmatella (Zetterstedt); Forsslund & Tjeder 1942: 95 [genera description].

Radema stigmatella (Zetterstedt); Kimmins & Denning 1951: 121, figs. 8-9 [male genitalia].

Apatania stigmatella (Zetterstedt); Lepneva 1971: 153-158, figs. 203-207 [larval description].

Parapatania stigmatella (Zetterstedt); Svensson & Tjeder 1975: 169 [distribution].

Apatania stigmatella (Zetterstedt); Mey & Dulmaa 1985: 92 [checklist, distribution].

Apatania stigmatella (Zetterstedt); Mey 1991b: 356 [checklist, distribution].

Apatania stigmatella (Zetterstedt); Gullefors 2005: 137 [larval habitat description].

Apatania stigmatella (Zetterstedt); Chuluunbat & Morse 2007: 54 [checklist, distribution].

Apatania stigmatella (Zetterstedt); Ivanov & Melnitsky 2007: 33 [distribution].

Description. Male (n=16), forewing length 7.9 mm, hind wing length 6.4 mm; female (n=22), forewing length 8.2 mm, hind wing length 6.6 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.22). Segment IX strongly widened anterolaterally, dorsal process visible laterally. Inferior appendage cylindrical bearing several long setae; harpago triangular in lateral aspect, broad at base, apically narrow pointed, curved laterad with numerous long bristles at inner surface. Superior appendage fused with external branches, represented by few setae at dorsal part. External branches flattened laterally, narrow at base, widened apically, triangular in lateral view; median process comprising 2 short slender lobes. Body of segment X with a pair of sclerotized process with 2 apical projections each, slightly shorter than external branches. Phallicata simple, apically emarginated, endothecal membrane visible. Parameres long slender, apically pointed, curved ventrolaterad.

Female genitalia (Fig. 4.48). Segment IX and X not distinct; lateral lobe (IXd) of segment IX undeveloped, posterior of segment IX with 2 lobes (IXb and IXc); sternum IX with a pair of subtriangular, membranous vulvar scales (e.gon.IX) connected with lateral lobes. Sternum VIII with long finger-like vulvar lobe (e.gon.VIII). Supragenital plate (Xe) sclerotized, broad compared with width of IX segment. Anal opening invisible ventrally. Internal spermathecal sclerite distinct from external gonopod.

Diagnosis. The male and female of this species both resemble *Apatania shoshone* Banks 1924, but differ from them by male having nondentate, regular margin of external

branches, and body of segment X with truncated apices. The female differs from it in having distinct internal spermathecal sclerite. But, *A. shoshone* is distributed only in the Nearctic region.

Distribution. Northern Europe; Russia (Kamtschatka, Siberia); Mongolia (West and Central parts); Canada.

Material examined. RUSSIA: Magadan District, Tenkinski Region, Jack London Lake, 6 Aug 1977, Coll. E.A. Makarchenko, Coll #-2203; 2 males, 2 females. MONGOLIA: Ovorhangay Aimag, Bat-Olziy Soum, braid of Orkhon Gol ~40 km W of Khujirt, N46.88586, E102.34386, elev 1646 m, 06-07 Jul 2004, Coll. SRP Team, light trap; 6 males. MONGOLIA: Arkhangay Aimag, Bulgan Soum, Urd Tamir Gol braid upstream of bridge, ~63 km SW of Tsetserleg, N47.11192, E101.01048, 2066 m, 13-15 Jul 2004, Coll. J. Gelhaus; 1 male. MONGOLIA: Arkhangay Aimag, Chuluut Soum, Khurmen/ Davaat Gol 15 km SSE of Chuluut/Jargalant, N47.42580, E100.30130, elev. 2104 m, 15-16 Jul 2004, Coll. SRP Team; 2 males, 3 females, light trap; 15 females, malaise trap; 1 male, 5 females. MONGOLIA:Arkhangay Aimag, Tariat Soum, Nariin Gichgenii Gol/Urd Terkh Gol ~5 km SE of Khorgo/Tariat, N48.12661,E99.94128, elev. 2019 m, 17-18 Jul 2004, Coll. SRP Team; 3 males, 14 females, light trap; 1 male, 61 females, malaise trap; 4 males, 79 females. MONGOLIA: Arkhangay Aimag, Khangay Soum, Urd Terkhiin Gol/Tatuur Gol ~10 km N of Khunt N47.94551,E99.40171, elev. 2108 m, 19 Jul 2004, Coll.S.Chuluunbat; 2 females. MONGOLIA:Zavkhan Aimag, Telmen Soum, Ideriin Gol ~15 km SSW of Telmen/Ovogdii, N48.53255,E97.52093, elev. 1823 m, 24-25 Jul 2004, Coll. J.Gelhaus, J.Morse; 10 females. MONGOLIA: Hovsgol Aimag,

Erdenebulgan Soum; Uur (Uuriin) Gol 32.6 km NE of Erdenebulgan, N50.30193; E101.92869, elev. 1063m; 14-15 Jul 2005, Coll. SRP Team; 1 male. MONGOLIA: Hovsgol Aimag, Tsagaan-Uur Soum; Uur (Uuriin) Gol 7.1 km N of Tsagaan-Uur, N50.60052; E101.52344, Elev. 1130m; 16-17 Jul 2005, Coll. Y.Oyunchuluun; 1 female. MONGOLIA: Hovsgol Aimag, Bayanzurkh Soum; Delger Moron Gol (upper), 8.3 km W of Bayanzurkh, N50.1628; E98.84213, elev. 1580m; 22 Jul 2005. Coll. S. Chuluunbat; 1 female. MONGOLIA: Hovsgol Aimag, Renchinlhumbe Soum, Jargalant Gol at Har-Us Springs 2 km SE of Renchinlhumbe, N51.07845, E99.70774, elev 1586 m, 1 Jul 2006, Coll. SRP Team; 1 male, 15 females. MONGOLIA: Hovsgol Aimag, Ulaan-Uul Soum, Unnamed bogs & streams 17 km NNE Ulaan-Uul 800 m W of outflow into Bagtagin Gol, N50.81208, E99.33531, elev 1590 m, 30 Jun 2006, Coll. S. Chuluunbat; 1 female. MONGOLIA: Hovsgol Aimag, Ulaan-Uul Soum, Guna Gol 11 km NNW of Ulaan-Uul, N50.77518, E99.18892, elev 1615 m, 4 Jul 2006, Coll. SRP Team; 3 females.

Apatania mirabilis Martynov

Figures 4.23 and 4.49

Apatania mirabilis Martynov 1909: 287, pl. 6, figs. 1-8 [adult male and female genitalia, front and hind wings].

Apatania mirabilis Martynov ; Martynov 1917: 61 [distribution].

Archapatania mirabilis Martynov ; Martynov 1935: 325 [bibliography].

Apatania mirabilis Martynov ; Schmid 1953: 158, fig. 26 [adult male and female genitalia].

Apatania mirabilis Martynov ; Schmid 1955: 80 [checklist].

Description. From Martynov 1909:

> "Male genitalia. Segment IX regular, laterally with small subtriangular projection above the pedes genitals. Preanal appendages small, elliptical. X segment with unpaired process and 4 faired processes. Inner pair which arranged closely to middle process; external appendages of the segment IX 2 broad vertical plates; above broad at the end and divided into 2 lobes, superior is longer posterior concave margin with some haired tubercles. Median process slightly broader, as long as inner appendages, somewhat excised at the end, beneath these appendages there is an irregular broad plate deriving from IX segment. First joint of pedes genitals long, second joint small, eggshaped. Penis forming a median portion, comprising ductus ejaculatorius and 2 side pieces in the form of 2 elongated plates. At the sides of the penis there are 2 titillatores, gradually attenuated to the apices, which are acute and curved inwardly. Female genitalia. Segment IX dorsally somewhat produced with slightly concave margin. Segment X dorsally attenuating to the apex, which has slight excision, laterally with convex upper and excised posterior margin; ventral half of segment shorter, divided into 2 rounded lobes; lateral lobes of the vulvar scale with small subacute inner projection each."

Male genitalia (Fig. 4.23). Inferior appendage cylindrical; harpago oval, directed laterad. Superior appendages small; external branches broadened posteriorly, triangular in lateral view; median process comprising long slender double processes, obliquely truncated at apex in lateral aspect. Body of segment X triangular in lateral view, dorsally double slender long processes. Phallus rather short, phallicata emarginated apically, gonopore groove visible dorsally. Parameres stout, apically pointed, directed lateroventrad.

Female genitalia (Fig. 4.49). Segment IX and X not distinct, lateral lobe (IXd) of IX segment undeveloped; posterior of IX segment with 2 lobes (IXb and IXc), IXb emarginated posteriorly. Sternum VIII with moderate, apically rounded vulval lobe (e.gon.VIII). Supragenital plate (Xe) short. Anal opening visible ventrally.

Diagnosis. The male of this species is similar to that of *A. stigmatella* by having harpago with numerous setae, but differs from it by having lack of strongly curved harpago and longer pair of median process.

Distribution. China (Goluboi region, East Tibet).

Material examined. None.

Apatania siniaevi Group

Synopsis of characters. Male genitalia with slender, short harpago (synapormophy 5); phallicata with a pair of membranous and sclerotized parts (synapomorphy 16); superior appendages small (phylogenetically equivocal); segment X membranous (phylogenetically equivocal). This group contains 2 species.

Apatania siniaevi Mey & Yang

Figure 4.24

Apatania siniaevi Mey & Yang 2001: 87, figs. 30-31 [adult male genitalia].

Description. From Mey & Yang 2001. "Forewing length 9.0 mm. Male genitalia: Inner branch of segment IX semicircularily curved, and with constriction of the segment IX in its ventral part. The new species is unique in having a pair of erectile aedeagal appendages which are sclerotized apically and covered with curved bristles."

Male genitalia (Fig. 4.24). segment X extremely narrowed at base of inferior appendage, dorsal process strongly projected. Inferior appendage long, broad at base narrowed apically; harpago slender, twice shorter than inferior appendage. Superior appendages short triangular; external branches long, at base strongly curved posteriorly and elevated;

single median process long slender, strongly curved mesally U-shaped, apically directed ventrad, in lateral aspect; internal branches fused with base of median process. Body of segment X membranous, arising from the base of appendages. Phallicata with 2 processes, long slender, sclerotized apically emarginated part, endotheca with long broad cylindrical semi-membranous part with numerous setae. Parameres long slender, apically pointed, directed laterad.

Female unknown.

Diagnosis. This species differs from other congeners by having strongly curved median process.

Distribution. China (Shaanxi).

Material examined. None.

Apatania pectinella Mey & Yang

Figure 4.25

Apatania pectinella Mey & Yang 2001: 87, figs. 32-36 [adult male genitalia].

Description. From Mey & Yang 2001. "Length of forewing 8-10 mm. The new species close relative of *A. bicruris* Leng & Yang, 1998. The main distinguishing characters are elongate inferior appendages and structure of phallic apparatus, especially the basal lobes of the parameres enlarged, rounded, in contrast to the short and triangular basal lobe of *A. bicruris*."

Male genitalia (Fig. 4.25). Sternum IX anteriorly expanded. Inferior appendage long strongly narrowed apically, bearing row of bristles in inner margin; harpago short slender with pointed apex. Superior appendage small, subtriangular in dorsal aspect; external branches 3 times longer than superior appendage, broad at base, narrowed apically curved

ventrad; a pair of median process, twice shorter than external branch. Body of segment X composed of triangular lobe with small membranous process on dorsal, visible in lateral aspect. Phallicata comprising with 3 pairs of process, deeply notched semi-membranous part dorsally, a pair of long sclerotized process and a pair of sclerotized stripes of phallocrypt (Fig. 4.25E). Apically pointed parameres and deeply notched membranous part ventrally shown in Figure 4.25D.

Female unknown.

Diagnosis. This species differs from other congeners by having row of bristles in inner margin of inferior appendage, and structure of phallicata.

Distribution. China (Shaanxi).

Material examined. None.

Species *incertae sedis*

Apatania yenchingensis Ulmer

Figures 4.26 and 4.50

Apatania yenchingensis Ulmer 1932: 67, figs. 41-43 [adult male and female genitalia].

Apatania yenchingensis Ulmer; Tsuda 1948: 102 [notes on description].

Apatania yenchingensis Ulmer; Schmid 1954: 52, figs. 86-87. [adult male and female genitalia].

Apatania yenchingensis Ulmer; Schmid 1955: 83 [checklist].

Description. Translated from German (Ulmer 1932):

> "Male genitalia. Preanal appendages small, forming in dorsally a horn-like outward curved process, in lateral view somewhat longer rod-shaped; the middle of part of the tergite X dorsally strongly straight intensified, somewhat longer than the preanal appendage, in lateral view a strong downward arranged hook forming; the outside horns of the tergite X arranged in dorsal, weakly curved apical part gradually continued to taper staff in an educated manner in lateral view inclined downward, somewhat swollen; the genital feet are very large; the first part is strongly parallel in lateral, the second part somewhat diminishes itself apically tapering either upward or bent in downward; the penis (usually completely covered by the genital feet) seems itself from broad softer basis in 2 forked apart, dark, strong, continued claw-like intensified and curved. Parameres somewhat upward. The female is apparently similarly as with *A. sinensis* Martynov."
> Translated from French (Schmid 1954):
> "Female genitalia. IX segment very broad and massive segment on its entire circumference; laterally, it carries a triangular thickening; its ventral lobes are not very prominent and have a side concavity. X segment in the shape of very prominent and widened pipe. Supragenital plate very short and entirely distinct. Vulvar lobe in the shape of long regular band."

Male genitalia (Fig. 4.26). Segment IX extremely narrowed at base of inferior appendage, dorsal process visible in lateral view. Inferior appendage long cylindrical; harpago twice shorter than inferior appendage, triangular, apically narrow. Superior appendages small, oval; external branches 3 times longer than superior appendages; single median process strongly curved ventrad. Body of segment X membranous, projecting from the base of other appendages. Phallicata sclerotized apically curved dorsad, gonopore visible, parameres short stout, membranous at base.

Female genitalia (Fig. 4.50). Segment IX and X not divided; lateral lobe (IXd) of IX segment slightly developed; tergite of segment IX with triangular shaped 2 lobes (IXb and IXc). Sternum VIII with long slender vulvar lobe (e.gon.VIII) with rounded apex.

Diagnosis. The male of this species is similar to that of *A. sinaevi*, but differs from it in having short strongly curved median process and lack of membranous process with numerous setae on phallicata.

Distribution. China (Northeast).

Material examined. None.

Apatania aberrans Martynov

Figures 4.27 and 4.51

Apatelia aberrans Martynov 1933: 153, figs. 26-32 [adult male and female genitalia].

Apatelia aberrans Martynov; Tsuda 1939a: 149 [checklist, distribution].

Apatelia aberrans Martynov; Tsuda 1939b: 291 [checklist].

Apatania aberrans Martynov; Schmid 1953: 161, figs. 30, 31 [adult male and female genitalia].

Apatania aberrans Martynov; Schmid 1955: 81 [checklist].

Apatania aberrans Martynov; Akagi 1975: 5, figs. 1-6 [larval description].

Description. Male (n=3), forewing length 8.2 mm, hind wing length 7.6 mm; female (n=3), forewing length 8.0 mm, hind wing 7.6 mm. Wing venation typical for the genus. Male genitalia (Fig. 4.27). Segment IX widened laterally, bearing large sclerotized rectangular plate with a shallow median incision on posterior margin. Inferior appendages with many setae; harpago flattened dorsoventrally and apex rounded. Superior appendages small semi-cylindrical; external branches cylindrical; single median process composed by internal branches of segment X and lobe of segment IX, apex pointed and directed posteroventrally. Body of segment X flattened dorsoventrally, formed 2 rounded

extentions pair of short lobes at dorsum of base. Phallus with phallicata bearing many blade-like bristles on ventral surface, few minute bristles along middorsal line, and several long blade-like bristles at posterolateral apex. Parameres long, slender, pointed apically.

Female genitalia (Fig. 4.51). Segment IX and X not distinct; lateral lobe (IXd) of IX undeveloped; posterior of segment IX divided into 2 lobes (IXb and IXc); sternum IX with 2 triangular, membranous vulvar scales (e.gon.IX). Sternum VIII with rounded apex of slender vulvar lobe (e.gon.VIII). Supragenital plate (Xe) moderately wide compared to width of IX segment, semi-memranous. Anal opening invisible ventrally.

Diagnosis. The male of this species differs from other congeners by having the ventral plate. The female of this species is similar to that of *A. sachalinensis*, but differs from it by having undeveloped lateral lobe of IX.

Distribution. Japan (Hokkaido, Kanagawa, Kumamoto, Akita, Nagano, Ishikawa and Kyushu Prefectures); Russia (Sakhalin and Kuril Islands).

Material examined. JAPAN: Oaza-Minamihotaka, Toyoshima-cho, Nagano Pref., 11 Oct 2002, H. Nishimoto; 3 males, 3 females (in 70% ethanol).

Apatania shirahatai Kobayashi

Figure 4.28

Apatania shirahatai Kobayashi 1973: 35, pl. 8, figs. E-H [male genitalia and wings].

Apatania shirahatai Kobayashi; Kobayashi 1983: 50, pl. 4, figs. 1-6 [male genitalia and wings].

Description. From Kobayashi 1973: "Forewing 7.3 mm, hind wing 5.65 mm. Male genitalia: IX segment divided into 2 pairs of lobes; inner lobes thumb-shaped, shorter than outer lobes; outer lobes wide, thin, spoon-shaped; apical margin of the IX segment with long 2 plates. Appendage paraeles long, 2 jointed; basal joint thick, thumb shaped, with a few setae; terminal joint chela-shaped, as long as basal joint. Penis long, apical portion nippers-shaped."

Male genitalia (Fig. 4.28). Segment IX widened laterally. Inferior appendages cylindrical; harpago apically curved laterad, broadened at base. Superior appendages with thin plate-like; external branches oblong, flattened laterally; a single median process bifurcate at apex, same length with superior appendages. Body of segment X comprising a pair of dorsoventrally flattened plates; each subtriangular in ventral view. Phallicata deeply notched apically. Parameres long slender, apically pointed, curved laterad.

Female unknown.

Diagnosis. This species is similar to those of *A. chokaiensis* and *A. ishikawai* by having bifurcate single median process but differs from them in having relatively longer harpago.

Distribution. Japan (Yamagata Prefecture).

Material examined. None.

Apatania crymophila McLachlan

Figures 4.29 and 4.52

Apatania crymophila McLachlan 1880: 44, pl. 55 [male genitalia].

Apatania crymophila McLachlan; Martynov 1914: 26, figs. 1-6 [male and female genitalia].

Apatania crymophila McLachlan; Martynov 1935: 330 [distribution].

Apatelia aenicta McLachlan; Ross 1938: 162, fig. 99 [synonym: species description, male genitalia].

Apatania crymophila McLachlan; Schmid 1954: 5, figs. 38-39 [male and female genitalia].

Apatania crymophila McLachlan; Schmid 1955: 81, fig 49 [checklist, male genitalia].

Apatania crymophila McLachlan; Lepneva 1971: 148-152, figs. 197-202 [larval description].

Apatania crymophila McLachlan; Mey & Dulmaa 1985: 91 [checklist, distribution].

Apatania crymophila McLachlan; Mey 1991b: 356 [checklist, distribution].

Apatania crymophila McLachlan; Chuluunbat & Morse 2007: 54 [checklist, distribution].

Apatania crymophila McLachlan; Ivanov & Melnitsky 2007: 33 [distribution].

Description. Male (n=3), forewing length 7.5 mm, hind wing length 6.6 mm; female (n=17), forewing length 8.0 mm, hind wing 7.0 mm. Wing venation typical for the genus. Male genitalia (Fig. 4.29). Segment IX widened ventrally, bearing row of several setae close to base of inferior appendage. Inferior appendages cylindrical bearing several long and many short setae, its base narrow; harpago covered with short fine setae, apically pointed and curved ventromesad, apex with heavily sclerotized, small triangular process. Superior appendages with several short setae and fused with external branches; external branches cylindrical in dorsal aspect, apex flattened laterally and bearing several short spine like setae; double median process slightly dilated at its upturned tip. Body of segment X composed of 2 contiguous, dorsoventrally flattened heavily sclerotized plates with truncate somewhat oblique apices, and formed tooth shape, its dorsal side slightly

covered with membranous. Phallus rather short, phallicata narrowed mesally, semi-membranous apex with many spinules, and curved ventrad; parameres straight slender pointed apically.

Female genitalia (Fig. 4.52). Segment IX and X divided laterally; lateral lobe (IXd) of IX segment slightly developed, posterior of IX segment composed of 2 lobes (IXb and IXc), and IXb notched posteriorly with many long setae; sternum IX with 2 semi-membranous triangular lobes (e.gon.IX) connected with lateral lobe (IXd) of IX. Sternum VIII with wide and short vulvar lobe (e.gon.VIII). Supragenital plate (Xe) heavily sclerotized oval. Anal opening invisible ventrally.

Diagnosis. The male of this species resembles that of *Apatania wallengreni* McLachlan 1876, but is distinguished from it in having widened apex of external branches and body of segment X formed tooth shape. *A. wallengreni* occurs in West Palearctic region.

Distribution. Russia (North western Siberia, Kamchatka, Khabarovskii Krai, district of Yenesei in Kolima); Canada; Mongolia (Selenge River Basin).

Material examined. RUSSIA: Khabarovskii krai, Ulchanskii region, Gera River, right tributary of Amur River, 2 km lower Bogorodskoje Village, 23 June 2000, Coll. T.M. Tiunova, Coll #-H.12; 2 males, 1 female. RUSSIA: Kamchatka, Krutaya River, 20 June 1969, Coll. I.M. Levanidova, Coll #-793; 1 male, 1 female. MONGOLIA: Tov, Erdene, Gorkhi Terelj National Park, Terelj Gol braid downstream of Terelj 10.6 km N of Mungut Rock Rd, N47.97.944,E107.47761, elev 1487 m, 05 Jul 2003, Coll: J. Gelhaus, Y. Oyunchuluun; 4 females. MONGOLIA: Tov, Erdene, Gorkhi Terelj National Park, Tuul R c. 100 m upstream of confluence with Terelj R, N47.96806,E107.59365, elev

1467 m, 05 Jul 2003, Coll. J Gelhaus; 3 females. MONGOLIA: Tov, Erdene, Gorkhi Terelj National Park, W Bayangin Gol at Tuul R Road crossing, N48.10757,E107.65918, elev 1492 m, 07 Jul 2003, Coll. S. Chuluunbat; 1 female. MONGOLIA: Tov, Erdene, Gorkhi Terelj National Park, Tuul River 10.1 km upstream of Tuul River Bridge, N48.09549,E107.84265, elev 1531 m, 08 Jul 2003, Coll. J. Morse, E. Sanaa; 7 females. MONGOLIA: Arkhangay Aimag, Ikhtamir Soum, E side of Khoit Tamir Gol 4 km NE of Ikhtamir, N47.59928,E101.24521, elev. 1602 m, 14 Jul 2004, Coll. S. Chuluunbat; 1 female.

Apatania complexa (Martynov)

Figures 4.30 and 4.53

Archapatania complexa Martynov 1935: 325, figs. 136-141 [adult male and female genitalia].

Apatania complexa (Martynov); Schmid 1953: 150, figs. 19, 20 [adult male and female genitalia].

Apatania complexa (Martynov); Schmid 1955: 80 [checklist].

Description. Male (n=1), forewing length 8.4 mm, hind wing length 7.2 mm; female (n=1), forewing length 9.0 mm, hind wing length 7.4 mm. Wing venation typical for the genus.

Male genitalia (Fig. 4.30). Segment IX narrowed dorsally, sternite with pale triangular lobe in lateral aspect. Inferior appendage cylindrical, narrowed at base; harpago long sinuate with 2 long heavily sclerotized bristles at apex. Superior appendages medium

cylindrical; external branches long slender with 3 long pale bristles at apex; median process composed of sclerotized a pair of sinuate slender and media sclerotized parts connected with external branches, its apex with minute setae; internal branches long slender, apex with several fine long setae. Body of segment X composed of semi-oval, heavily sclerotized outer parts and medially emarginated, semi-membranous roof-shaped parts. Phallicata apex curved ventrad, with mushroom shaped apex in ventral aspect; parameres rather short stout, its base membranous with many spinules.

Female genitalia (Fig. 4.53). Segment IX and X distinct; lateral lobe (IXd) of IX undeveloped, posterior of IX segment composed of 2 slightly fused lobes (IXb and IXc). Sternum IX with sharp elongated oval shape membranous vulvar scales (e.gon.IX). Sternum VIII with relatively wide, short vulvar lobe (e.gon.VIII). Supragenital plate (Xe) wide, sclerotized. Anal opening visible ventrally.

Diagnosis. The male of this species is similar to that of *A. crymophila*, but differs from it by having well developed superior appendage; slender harpago with 2 spines and thick parameres. The female of this species is similar to those of *A.mirabilis* and *A. tsudai*, but differs from them in having distinct shape of internal spermathecal sclerite and anal opening.

Distribution. Russia (Vinogradovka and Evseevka vicinities, and South Ussurian Region).

Material examined. RUSSIA: Primorskii Krai, Kedrovaya Pad reserve, Goraiskii Stream, 13 May 2004, Coll. T. Arefina; 1 male, 1 female (in 90% ethanol).

CHAPTER V: DISCUSSION

The external morphologies of adult males and females of East Palearctic species of *Apatania* only were studied, since other life history stages are insufficiently known to contribute to a phylogenetic analysis. Thirty species are known from adult stages, male or female or both. Twenty-eight of them are known from the male and 2 species are known only from the female and probably are parthenogenic (Table. 5). Males and females captured at the same time and place were considered to be the same species. Otherwise, males and females described as belonging to a particular species by previous authors were considered conspecific.

Twenty-one of the most phylogenetically informative characters were used to infer historical relationships. The resulting cladogram revealed 8 new species groups. The single most parsimonious cladogram had tree length = 23, consistency index (CI) = 0.91, retention index (RI) = 0.95, and rescaled consistency index (RC) = 0.87. There were 2 homoplasies. Tree length is the total number of steps required to map a dataset onto a phylogenetic tree, CI is a measure of how well an individual character fits on the phylogenetic tree (a value closest to 1 is the best fit), RI measures the ratio of apparent synapomorphy to actual synapomorphy, and RC is the product of the consistency index and the retention index.

All East Palearctic *Apatania* species share 4 common synapomorphies, shown in Figure. 1, indicating that the genus *Apatania* is monophyletic in the East Palearctic Region. I have examined several species from North America and Europe, and these

examined species had the same 4 synapomorphies, suggesting that they may be present in all *Apatania* and the entire genus *Apatania* is monophyletic.

The genus *Apatidelia* shares 2 synapamorphies (hind wing discoidel cell open, short m-cu crossvein between M3+4 and Cu1a) with genus *Apatania*, but has at least one synapomorphy (presence of lateral lobes on sternum V of the male). Thus, *Apatania* and *Apatidelia* apparently are each monophyletic and are sister lineages. I did not examine any specimens of *Apatidelia*, which includes only 3 species which are known only as males. A decision about the categorical rank of *Apatania* and *Apatidelia* is subjective. Whether these are separate sister genera or are subgenera in the same genus is generally determined by their diagnostic distinctiveness in various life history forms. Therefore, a decision about the ranks of these genus-group names must await discovery of other life history forms for the species of *Apatidelia*.

Eight new species groups discussed in the text (Fig. 1) resulted from the cladistic analysis in this study. These species groups do not correspond with the supergroups, groups and subgroups of Schmid (1953) (Table 5). Schmid's results were based on descriptions of several representative species in each group. His inferences of the phylogenetic relationships within the genus *Apatania* were based on sexually dimorphic characters in the forewing pterostigma region and in the relative complexity of the genitalia. These groupings were subjective with limited explicit criteria, and it is doubtful that modern cladistic methods were employed.

I observed several biogeographic groupings based on species distributions in the different species groups (Fig. 1). Two species groups (*A. tsudai* and *A. chokaiensis*

Groups) are Japanese endemics and 1 species group (*A. siniaevi* Group) is endemic to China. Other groups had the following distributions: One group (*A. momoyaensis* Group) is remarkably disjunct (with *A. tcharvakensis* in Uzbekistan and *A. momoyaensis* in Japan). In the *A. zonella* Group, *A. majuscula* and *A. mongolica* are Mongolia-centered (distributed in Irkutsk, Sajan Mountains, northcentral Mongolia, and Ala-chan Mountain in northcentral China). Also in the *A. zonella* Group, the monophyletic group of 4 species most closely related to *A. zonella* is widespread (for example, *A. zonella* is distributed throughout Europe, Russia, Canada, and Greenland). In the *A. copiosa* Group, the monophyletic group of 3 species including *A. sarkandensis*, *A. maritima,* and *A. ulmeri* constitute a West-East group (distributed in Kazakstan, southcentral Russia, and northern China). The remaining 3 species of the *A. copiosa* Group (*A. sinensis*, *A. hamardabanica* and *A. copiosa*) are monophyletic and widespread (China, Russia, Turkestan, and Kazakstan). The *A. parvula* Group is centered in Japan-Far East Russia (distributed in Far East Russia, Kurile Island and Japan). The *A. stigmatella* Group is widespread (for example, *A. stigmatella* is distributed throughout Canada, Europe, Russia, and Mongolia).

Intraspecific differences of the phallic apparatus are widespread, so that among East Palearctic *Apatania* species some close relatives have been difficult, and at times impossible to diagnose. For example, *A. zonella* and *A. dalecarlica* females and males exhibit very few and inconsistent differences. *Apatania nikkoensis* is similar to these 2 species, but *A. nikkoensis* occurs only in Japan. *Apatania crassa* and *A. parvula* are a comparable situation: because they are so similar and slight morphological differences occur naturally among different populations (Levanidova, 1979), there is weak support

for considering them separate species. *Apatania majuscula* and *A.doehleri* also have this problem, as I have observed slight morphological differences occurring in different habitats.

The mitochondrial COI gene of several species of *Apatania* from the Holarctic Region have been barcoded by Zhou. Preliminary analysis shows a cluster that includes *A. zonella*, *A. dalecarlica*, A. *doehleri*, *A. majuscula*, *A. hispida*, and *A. forsslundi* with shallow divergences among species. At least some of them (e.g., *A. zonella*, *A. majuscula*) are Holarctic, with transcontinental distributions. All *Apatania* species that have been recorded in Mongolia have been barcoded, including *A. majuscula* and *A. doehleri*. These 2 species show only slight divergence between them (Xin Zhou, personal communication, October 2008). It is possible that vicariant speciation is not complete in these taxa, which would explain the low divergence in their COI sequences.

The problem is further confounded when different taxonomists have different species concepts and when the same taxon may be called different names by different people or in different countries. For these reasons, I propose that *A. crassa* Schmid, 1953, is a synonym of *A. parvula* Martynov, 1935, and that *A. doehleri* Schmid, 1954, is a synonym of *A. majuscula* McLachlan, 1872.

CHAPTER VI: CONCLUSIONS

Thirty-two East Palearctic *Apatania* species have been described up to now as adults. Two others (*Apatania kitagamii* Iwata, 1927; *Apatania iijimae* Iwata, 1928) are known only in the larval life stage and are not described further in this work (Table 5).

Examination of adult males and females resulted in 2 subjective synonyms: *A. crassa* Schmid, 1953, is a synonym of *A. parvula* Martynov, 1935, and *A. doehleri* Schmid, 1954, is a synonym of *A. majuscula* McLachlan, 1872, based on the absence of conspicuous differences in the genitalic apparatus, especially appendages of segment X, in different populations. Consequently, 32 East Palearctic *Apatania* species are considered valid and 30 were illustrated and redescribed in this study.

Genitalic and venational synapomorphies of East Paleartic *Apatania* species have been inferred and new species groups suggested by the resulting phylogenetic analysis. The cladogram has tree length 23, consistency index (CI) 0.91, retention index (RI) 0.95, and rescaled consistency index (RC) 0.86, with two homoplasies and with the topology shown in Figure 1. All East Palearctic *Apatania* species share 4 synapomorphies, which indicates that at least this part of the genus *Apatania* is monophyletic. The phylogeny does not support Schmid's (1953) grouping of *Apatania* species. Eight new species groups (the *Apatania tsudai*, *A. momoyaensis*, *A. zonella*, *A. copiosa*, *A. chokaiensis*, *A. parvula*, *A. stigmatella* and *A. siniaevi* Groups) and 6 species *incertae sedis* are recognized (Table 5).

Several biogeographic groupings are recognized based on their species distributions. Two Japanese endemic groups, a Chinese endemic group, 3 widespread groups, a disjunct group, a Mongolia-centered group, a West-East group, and a Japan-Far East Russia group were observed (Fig. 1).

Illustrated keys to the males and females of East Palearctic *Apatania* species are provided.

Future study is needed to sequence more-rapidly evolving genes of *Apatania* species, especially for different populations of the species, which will give a better understanding for *Apatania* species distinctions and ability to associate different life stages. Sequences of more-slowly evolving genes will help refine phylogenetic relationships. Such molecular studies will help especially for improving our understanding of Mongolian species diversity, clarifying the number of species of *Apatania*, and building our own biotic indices for biomonitoring of water quality.

APPENDICES

APPENDIX A

Table 1. Classification, species diversity, and distribution of family Apataniidae. EP = East Palearctic, NA = Nearctic, OL = Oriental, WP = West Palearctic.

Current classification	# of species	Biogeographical Regions
SUPERFAMILY LIMNEPHILOIDEA Kolenati 1848		
FAMILY Apataniidae Wallengren 1884		
SUBFAMILY Apataniinae Wallengren 1884		
TRIBE Apataniini Wallengren 1884		
GENUS **Apatania** Kolenati 1847	95	EP, WP, NA and OL
GENUS Apataniana Mosely 1936	16	EP, WP and OL
GENUS Apatidelia Mosely 1942	3	OL (China)
GENUS Talgara Mey 1991	1	EP (Kazakhstan)
TRIBE Baicalinini Martynov 1914		
GENUS Baicalina Martynov 1914	5	EP (Lake Baikal endemic)
GENUS Protobaicalina Ivanov & Menshutkina 1996		
SUBGENUS Protobaicalina I & M 1996	2	EP (Lake Baikal endemic)
SUBGENUS Pseudobaicalina I & M 1996	2	EP (Lake Baikal endemic)
TRIBE Thamastini Schmid 1953		
GENUS Baicalinella Martynov 1924	1	EP (Lake Baikal endemic)
GENUS Baicaloides Martynov 1924	1	EP (Lake Baikal endemic)
GENUS Protoradema Ivanov 2002	2	EP (Lake Baikal endemic)
GENUS Radema Hagen 1864	1	EP (Russia)
GENUS Thamastes Hagen 1858	1	EP (Russia)
TRIBE *incertae sedis* in subfamily Apataniinae		
GENUS Proradema Mey, 1993	1	EP (Russia)
SUBFAMILY Moropsychinae Schmid 1953		
GENUS Moropsyche Banks 1906	30	EP and OL
GENUS Notania Mosely 1950	5	OL (India and Myanmar)
SUBFAMILY *incertae sedis* in family Apataniidae		
GENUS Allomyia Banks 1916	23	EP and NA
GENUS Manophylax Wiggins 1973	6	EP and NA
GENUS Moselyana Denning 1949	1	NA (United States)
GENUS Pedomoecus Ross 1947	1	NA (United States)

Table 2. Characters and states used in the phylogenetic analysis.

#	Structure	Outgroup character	Synapomorphy
1	Hind wing discoidal cell	closed	open
2	Front wing distance of m-cu between M3+4 and Cu1a	long	short
3	Membranous appendages on tip of vulvar lobe of female genitalia	present	absent
4	Female supragenital plate	paired	single
5	Harpago	long	short
6	Inferior appendage basal projection	absent	present
7	Male segment IX ventral processes	absent	present
8	Inferior appendage distal projection	absent	present
9	Lateral lobe of segment IX female	undeveloped, without posterolateral extension	well developed, with strong posterolateral extension
10	Long median process	straight, slight bend ventrad	acutely curved ventrad, C-shaped
11	Appearance of segment X, supragenital plate.	apex of segment X does not reach supragenital plate, with a great distance	apex of segment X reaches supragenital plate, produce a pair of ear-like projection
12	External branches	short	long
13	Apical setae on long external branch	absent	present
14	External branch direction	straight	curved ventrad with strong angle
15	Single spine at tip of external branch	absent	present
16	Phallicata with a pair of membranous lobes, and sclerotized parts	absent, simple single part	present
17	Single median process	not bifurcate	apically bifurcate
18	Harpago apex direction	apically pointed strait	apically curved, directed ventrad

19	A tuft of short hairs at posterolateral edges of each inferior appendage	absent	present
20	Inner side of harpago with numerous long hairs	absent	Present
21	Short external branch lobe apices	narrow, cylindrical	broad, subtriangular

Table 3. Matrix of characters listed in Table 2, with plesiomorphies indicated by “0,” synapomorphies by “1,” and unknown conditions by “?.”

Species list	Character states																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
A. aberrans	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. tcharvakensis	1	1	?	?	0	1	0	0	?	0	?	0	0	0	0	0	0	0	0	0	0
A. sachalinensis	1	1	1	1	?	?	?	1	1	?	0	?	?	?	?	?	?	?	?	?	?
A. tsudai	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. kyotoensis	1	1	?	?	0	0	1	0	?	0	?	0	0	0	0	0	0	0	0	0	0
A. zonella	1	1	1	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0
A. lenica	1	1	1	1	?	?	?	?	1	0	1	?	?	?	?	?	?	?	?	?	?
A. majuscula	1	1	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
A. hamardabanica	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
A. copiosa	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
A. shirahatai	1	1	?	?	0	0	0	0	?	0	?	0	0	0	0	0	1	0	0	0	0
A. dalecarlica	1	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
A. sarkandensis	1	1	1	1	1	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0
A. mongolica	1	1	?	?	1	0	0	1	?	1	?	0	0	0	0	0	0	0	0	0	0
A. sinensis	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
A. ulmeri	1	1	?	?	1	0	0	0	?	0	?	1	0	1	1	1	0	0	0	0	0
A. maritima	1	1	1	1	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0
A. parvula	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
A. insularis	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
A. mirabilis	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
A. pectinella	1	1	?	?	1	0	0	0	?	0	?	0	0	0	0	1	0	0	0	0	0
A. yenchingensis	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. siniaevi	1	1	?	?	1	0	0	0	?	0	?	0	0	0	0	1	0	0	0	0	0
A. chokaiensis	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
A. complexa	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. momoyaensis	1	1	?	?	0	1	0	0	?	0	?	0	0	0	0	0	0	0	0	0	0
A. ishikawai	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
A. nikkoensis	1	1	1	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0
A. crymophila	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. stigmatella	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Table 4. List of morphological abbreviations.

Head

an.so. Antennal socket
antf. Antennifer
at.p. Anterior tentorial pit
cd. Cardo
cg.g. Clypeogenal groove
cg.sw. Clypeogenal setal warts
cl.g. Clypeolabral groove
co.g. Coronal groove
com.e. Compound eye
d.lab.sc Distal labial sclerite
fc.sw. Frontoclypeus setal warts
fg.g. Frontogenal groove
fla. Flagellum
ge. Gena
h. Haustellum
h.sc. Haustellar sclerite
lab.p. Labial palps
labr. Labrum
lac. Lacinia
l.oc. Lateral ocellus
md. Mandible
m.oc. Median ocellus
mx.p. Maxillary palps
ob.sc Oblique sclerotization
occ. Occiput
occ.c. Occipital condyle
occ.sw Occipital setal warts
op.g. Occipito-postgenal groove
ped. Pedicel
pge. Postgena
pge.sw. Postgenal setal warts
scp. Scape
sge. Subgena
sens.p. Sensory pits
so.g. Subocular groove
st. Stipes
vlc.sw. Vertexal lateroantennal compact setal warts
vmc.sw. Vertexal medioantennal compact setal warts
vmd.sw. Vertexal medioocellar diffuse setal warts

Thorax

lt.pt.sw. Lateral pronotal setal warts
md.pt.sw. Medial pronotal setal warts
ms.ntm. Mesonotum
ms.sct. Mesoscutum
ms.sctl. Mesoscutellum
mt.ntm. Metanotum
mt.sct. Metascutum
mt.sctl. Metascutellum
pms.sctl. Postmesoscutellum
sct.sw. Scutum setal warts
sctl.sw. Scutellar setal warts

Wing venation

I, II, III, V. Forks 1, 2, 3, 5.
A. Anal vein
C. Costal vein
Cu. Cubital vein
cu. Cubital cross vein
cu-a. Cubital-anal cross vein
dsc.cl. Discoidal cell
fr.st. Frenular setae
hml.v. Humeral crossvein
JB. Jugal bar
M. Medial vein
thd.cl. Thyridial cell
m-cu. Medial-cubital crossvein
R. Radial vein
r-m. Radial-medial crossvein
r3-r4. Sectoral crossvein
Sc. Subcostal vein
sc-r. Subcostal-radial crossvein

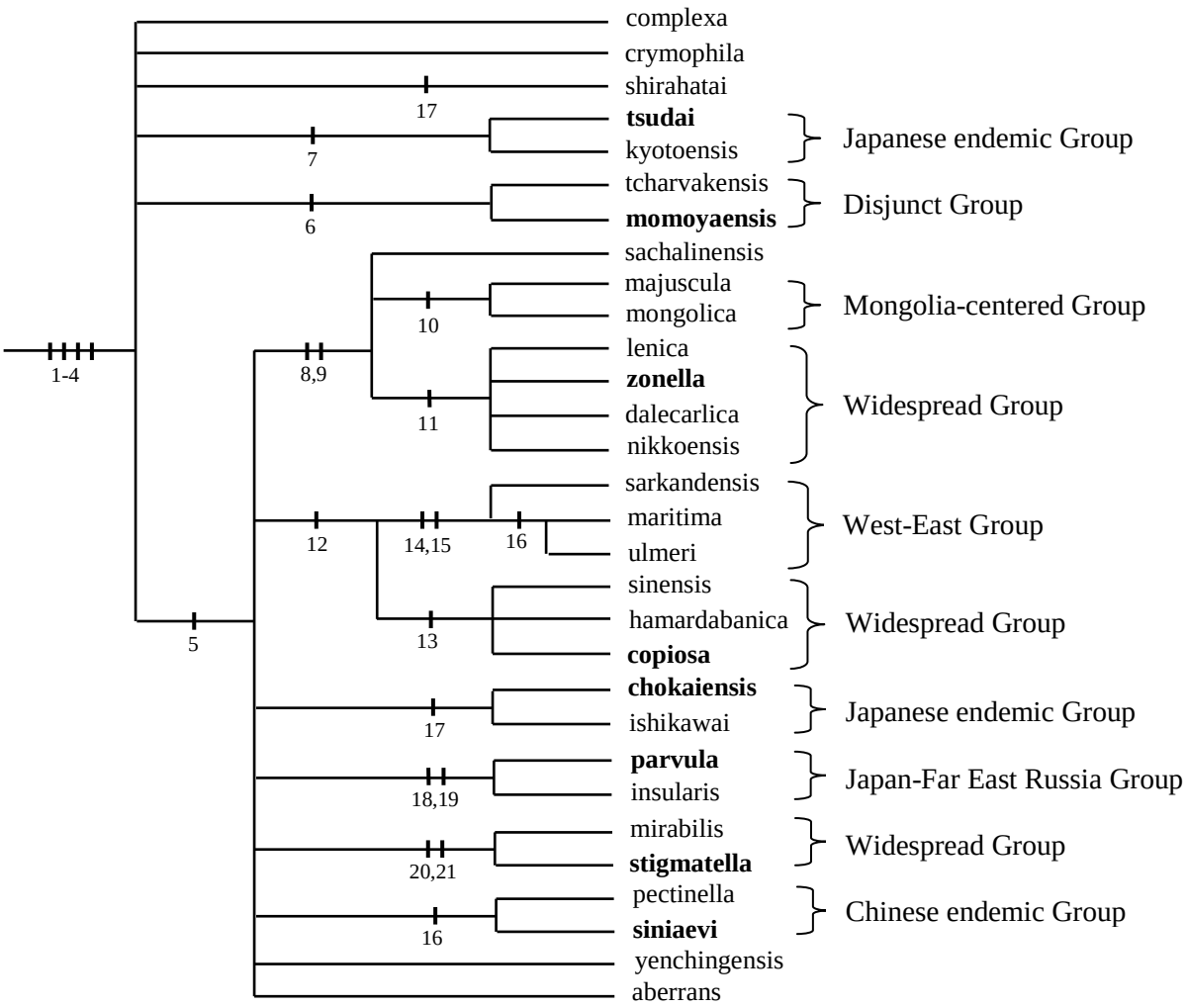
Genitalia

VIIIs. Abdomnal sternite VIII
VIIIt. Abdominal tergite VIII
IX. Abdominal segment IX
IXa-d. Outgrowths of segment IX/Lobes
Xb, c. Outgrowths of segment X/Lobes
Xe. Outgrowth of segment X/Supragenital plate
ac. Antecosta of segment IX
an. Anus/Anal opening
ap. Phallic apodeme
bo.X. Body of segment X
bp.inf. Basal plate of inferior appendage
dpr. Dorsal process of segment IX
e.gon.VIII. External part of gonopod VIII/Vulvar lobe
e.gon.IX. External part of gonopod IX/Vulvar scale
end. Endophallus
ext.br. External branch of segment X/Lateral process of segment X
fp.rd. Flexible part of rod-like sclerite
gon. Gonopore/Dorsal groove
hrp. Harpago
hpr.ll. Lower lip of harpago
hpr.ul. Upper lip of harpago
inf.ap. Inferior appendage/Coxopodite
inf.bp. Basal projection of inferior appendage
inf.dp. Distal projection of inferior appendage
int.br. Internal branch of segment X
lp.prm. Lateral process of paramere
me.pr. Median process of segment X
phb. Phallobase
phcr.sc. Sclerotized stripes of phallocrypt
phl. Phallicata
phls. Setae of phallicata
prm. Parameres
rd.sc. Rod-like sclerite
sp.ap. Superior appendage/Preanal appendage
spt.sc. Spermathecal sclerite
ve.pl. Ventral plate of segment IX
ve.pr. Ventral process of segment IX

Table 5. Associated life stages and revised species groups for the East Palearctic species of the *Apatania*, along with Schmid's (1953) groups. No pupae or eggs have been described for *Apatania* species of the East Palearctic Region.

East Palearctic *Apatania* species	Species Groups in This Revision	Schmid (1953) Supergroups/Groups/Subgroups	Known life stages		
			Male	Female	Larva
A.tsudai	A.tsudai Group	wallengreni/tsudai/	X	X	
A.kyotoensis	A.tsudai Group	fimbriata/fimbriata/kyotoensis	X		
A.momoyaensis	A.momoyaensis Group		X		
A.tcharvakensis	A.momoyaensis Group		X		
A.zonella	A.zonella Group	fimbriata/fimbriata/fimbriata	X	X	X
A.dalecarlica	A.zonella Group		X	X	
A.nikkoensis	A.zonella Group	wallengreni/tsudai/	X	X	
A.lenica	A.zonella Group			X	
A.majuscula	A.zonella Group	fimbriata/fimbriata/fimbriata	X	X	X
A.mongolica	A.zonella Group	fimbriata/fimbriata/mongolica	X		
A.sachalinensis	A.zonella Group	complexa/aberrans/		X	
A.copiosa	A.copiosa Group	fimbriata/fimbriata/malaisei	X	X	X
A.hamardabanica	A.copiosa Group		X	X	
A.sinensis	A.copiosa Group	fimbriata/fimbriata/malaisei	X	X	
A.ulmeri	A.copiosa Group	fimbriata/fimbriata/malaisei	X		
A.maritima	A.copiosa Group		X	X	
A.sarkandensis	A.copiosa Group		X	X	
A.chokaiensis	A.chokaiensis Group		X	X	
A.ishikawai	A.chokaiensis Group		X	X	
A.parvula	A.parvula Group	complexa/crassa/	X	X	
A.insularis	A.parvula Group		X	X	
A.stigmatella	A.stigmatella Group	wallengreni/stigmatella/	X	X	X
A.mirabilis	A.stigmatella Group	complexa/complexa/	X	X	
A.siniaevi	A.siniaevi Group		X		
A.pectinella	A.siniaevi Group		X		
A.yenchingensis	Species Incertae sedis	fimbriata/yenchingensis/	X	X	
A.aberrans	Species Incertae sedis	complexa/aberrans/	X	X	X
A.shirahatai	Species Incertae sedis		X		
A.crymophila	Species Incertae sedis	wallengreni/wallengreni/wallengreni	X	X	X
A.complexa	Species Incertae sedis	complexa/complexa/	X	X	
A.kitagamii	None				X
A.iijimae	None				X

Figure 1. Phylogenetic analysis of East Palearctic *Apatania* species. Numbers in the nodes represent the characters and states in Table 2. Bold names indicate the names of the monophyletic Species Groups. Brackets show geographic distribution groupings.



APPENDIX B

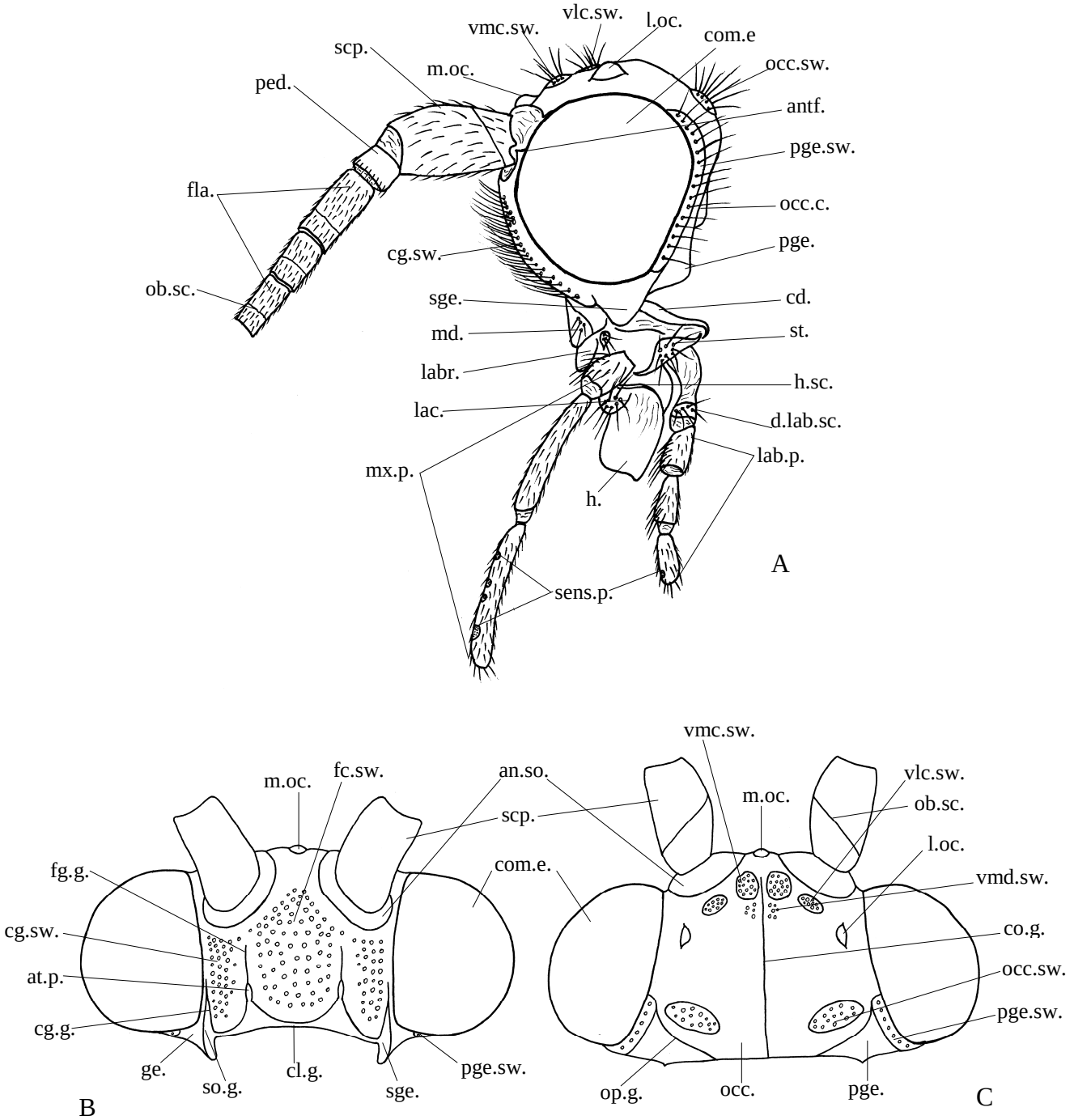


Figure 3.1. Morphology of adult male head of *Apatania stigmatella* (Zetterstedt). A) left lateral view, B) anterior view, C) dorsal view.

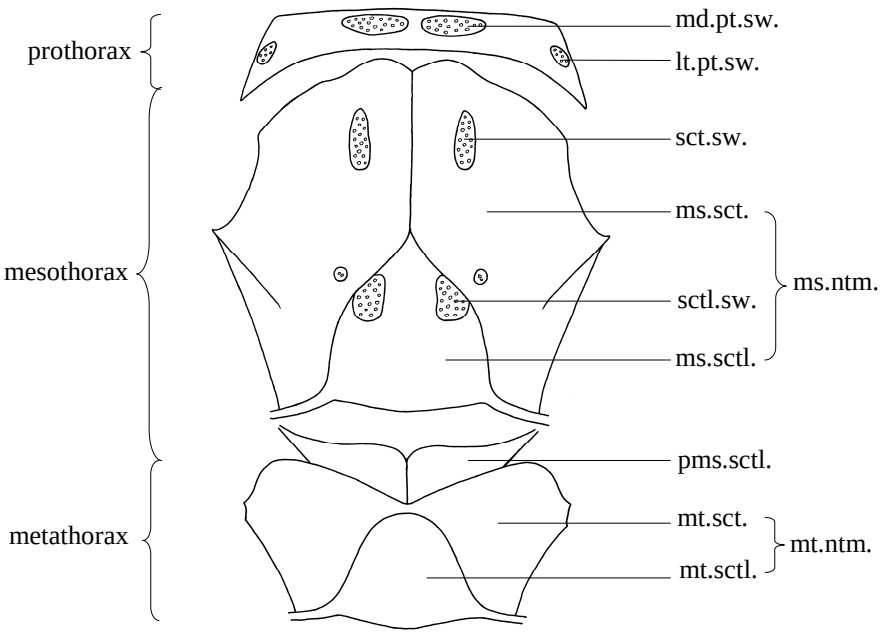


Figure 3.2. Thorax of *Apatania stigmatella* (Zetterstedt). Dorsal view.

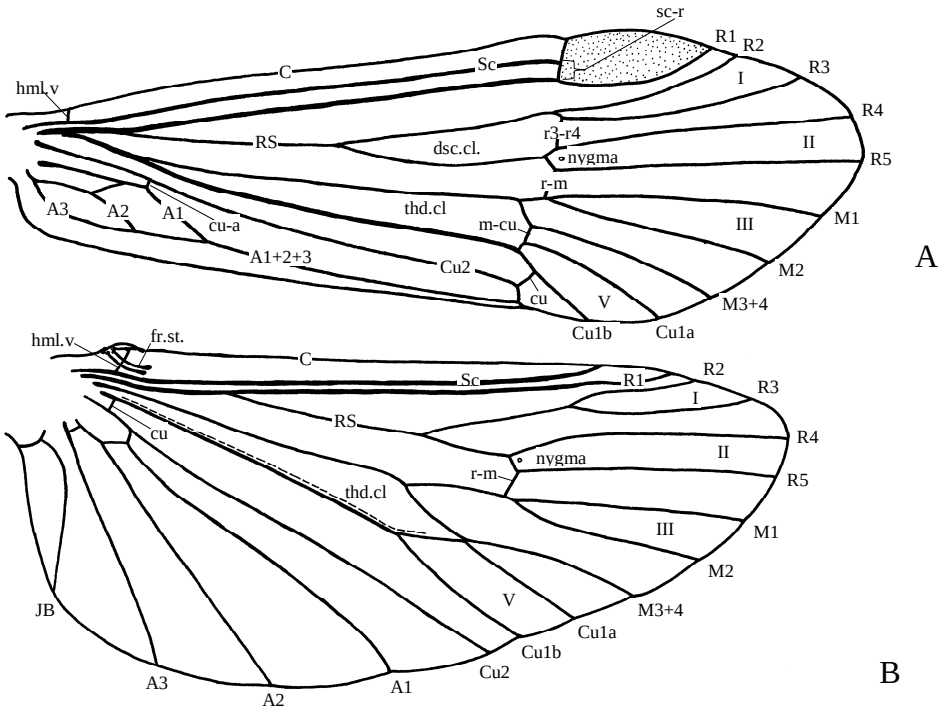


Figure 3.3. Wing venations of male *Apatania stigmatella* (Zetterstedt). A) dorsal view of forewing, B) dorsal view of hind wing.

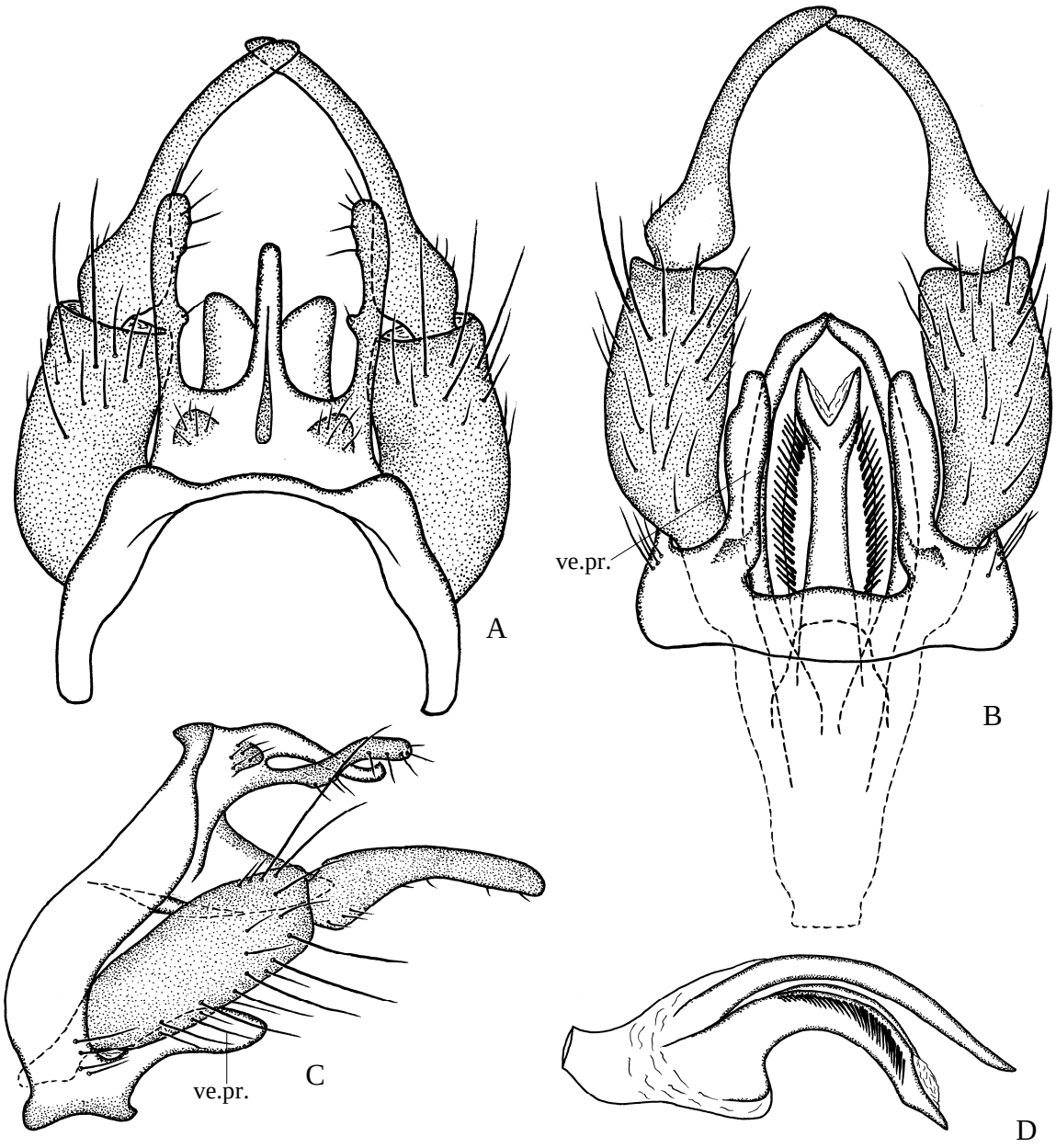


Figure 4.1. Male genitalia of *Apatania tsudai* Schmid. A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, D) left lateral view of phallus.

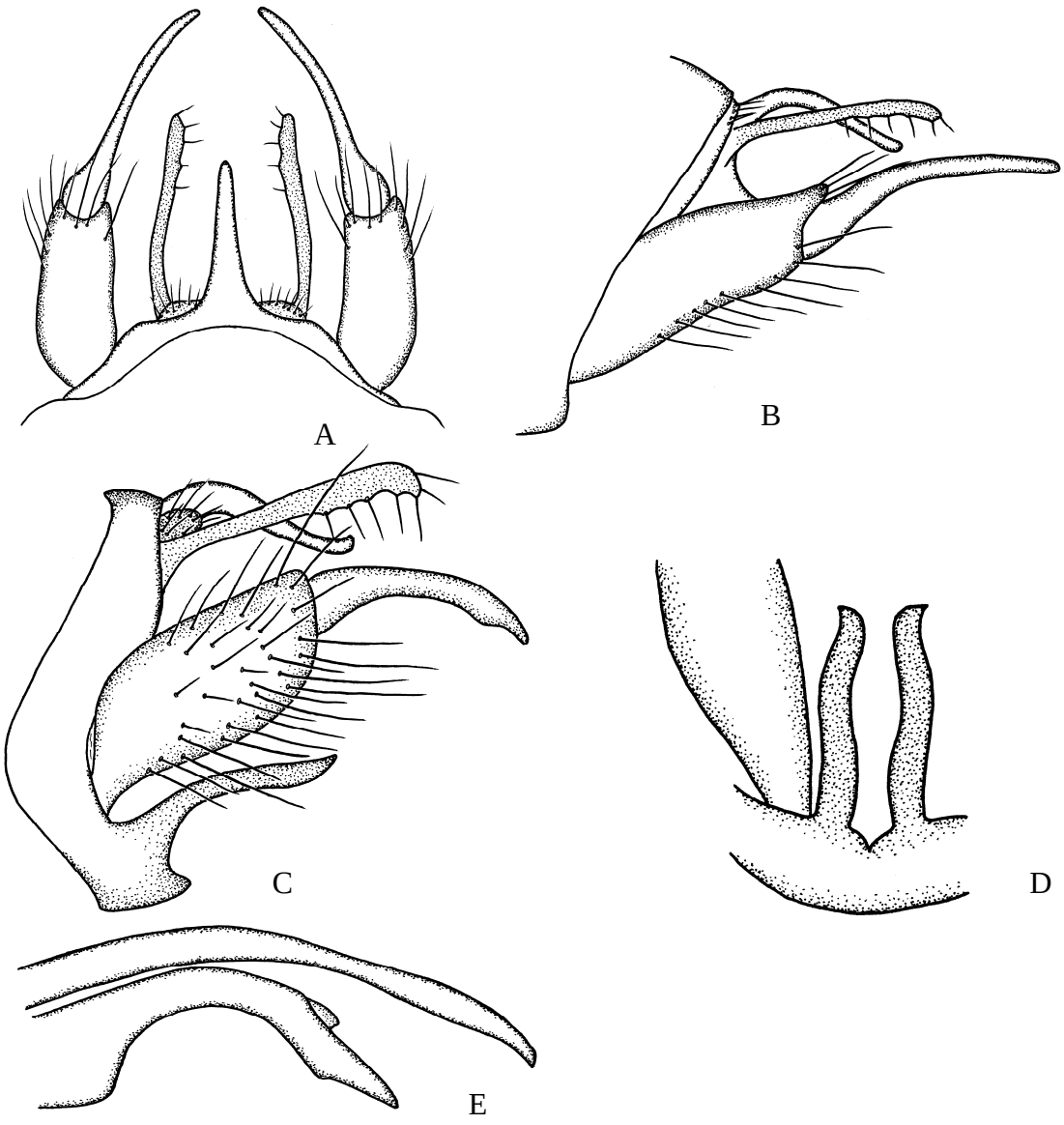


Figure 4.2. Male genitalia of *Apatania kyotoensis* Tsuda. A) dorsal view, and B) left lateral view, redrawn from Tsuda 1939. C) left lateral view, D) ventral view, and E) left lateral view of phallus apex, redrawn from Schmid 1954.

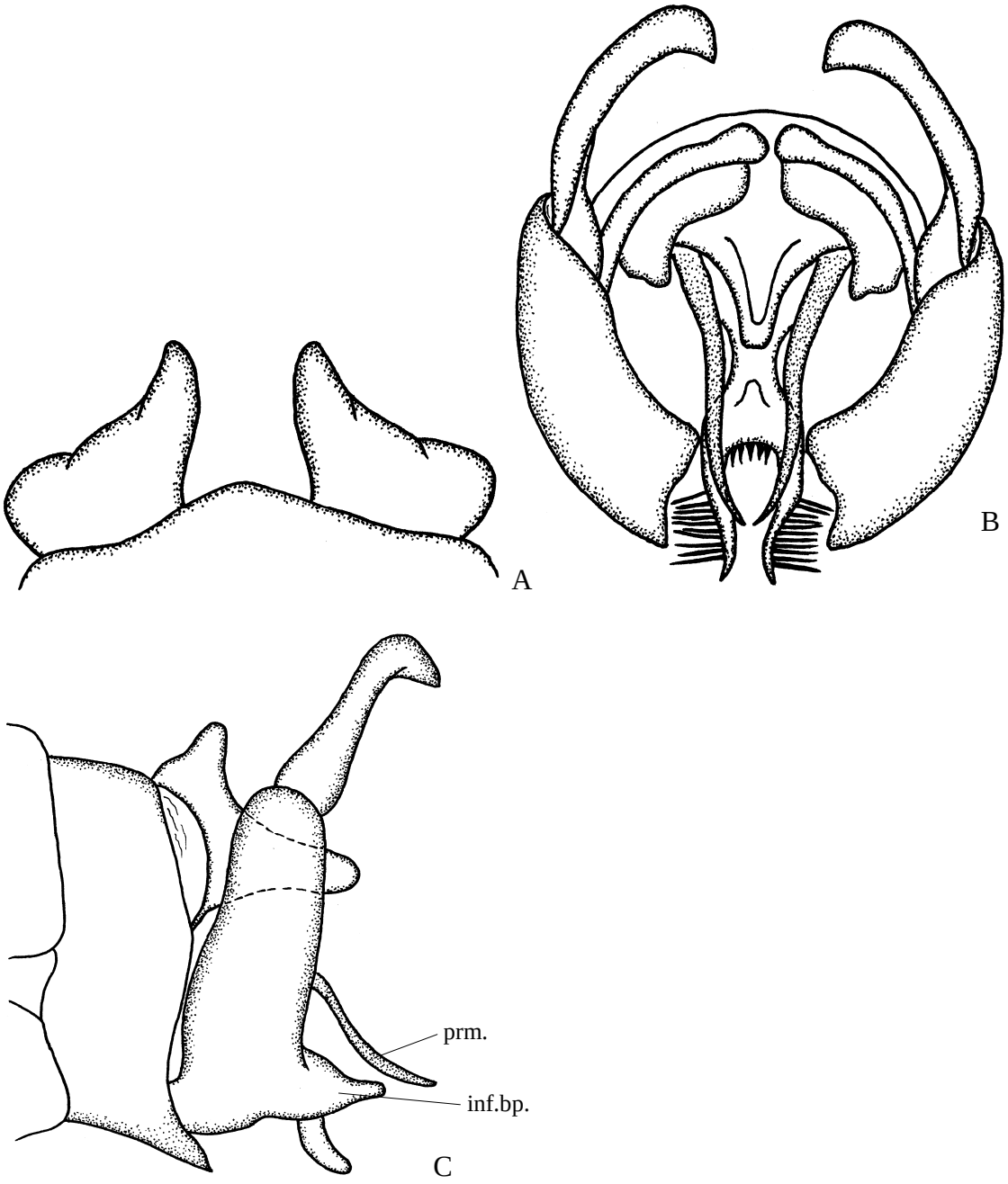


Figure 4.3. Male genitalia of *Apatania momoyaensis* Kobayashi. Redrawn from Kobayashi 1973. A) dorsal view, B) caudal view, phallus *in situ*, C) left lateral view.

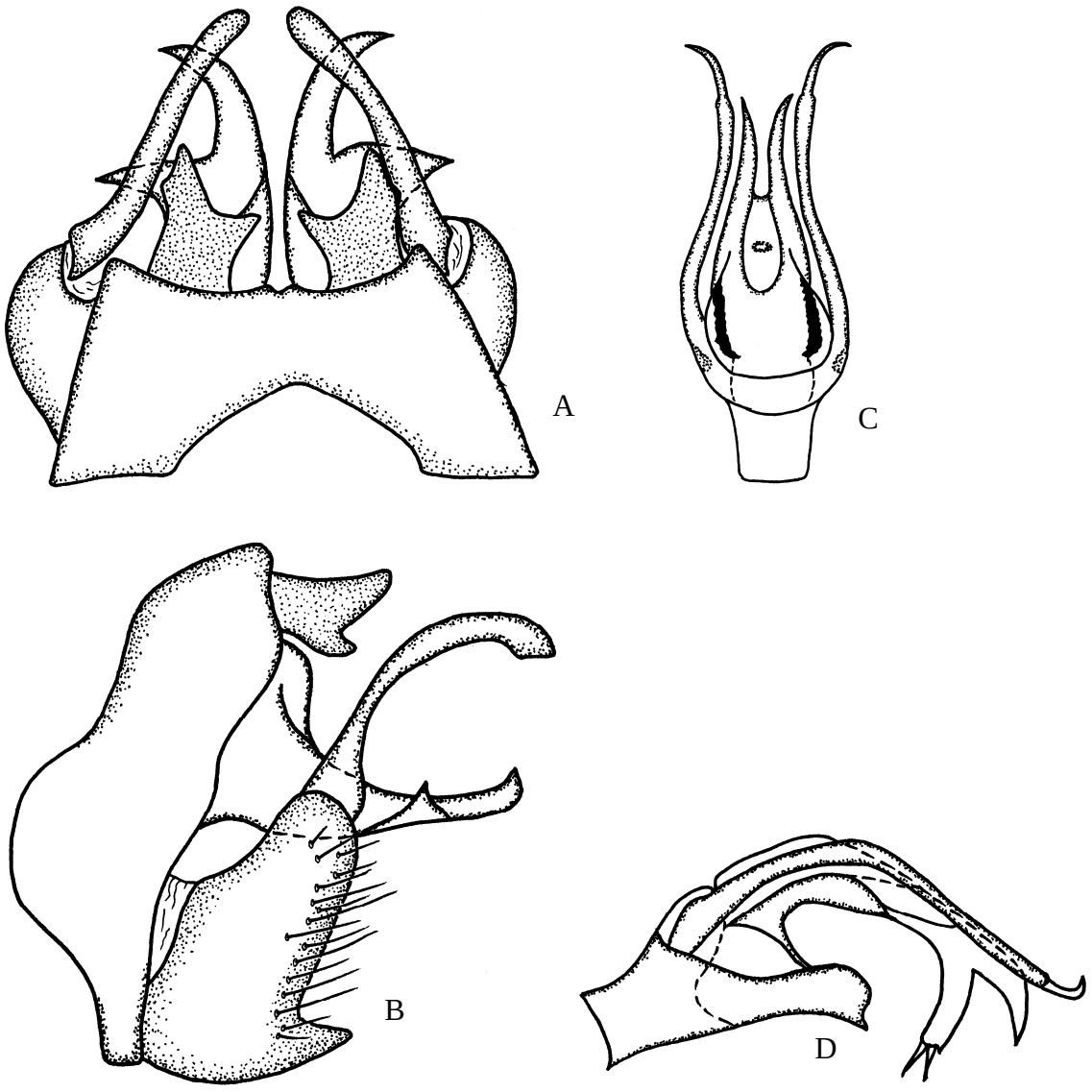


Figure 4.4. Male genitalia of *Apatania tcharvakensis* Ivanov. Redrawn from Ivanov 1991. A) dorsal view B) lateral view C) dorsal view of phallus, D) left lateral view of phallus.

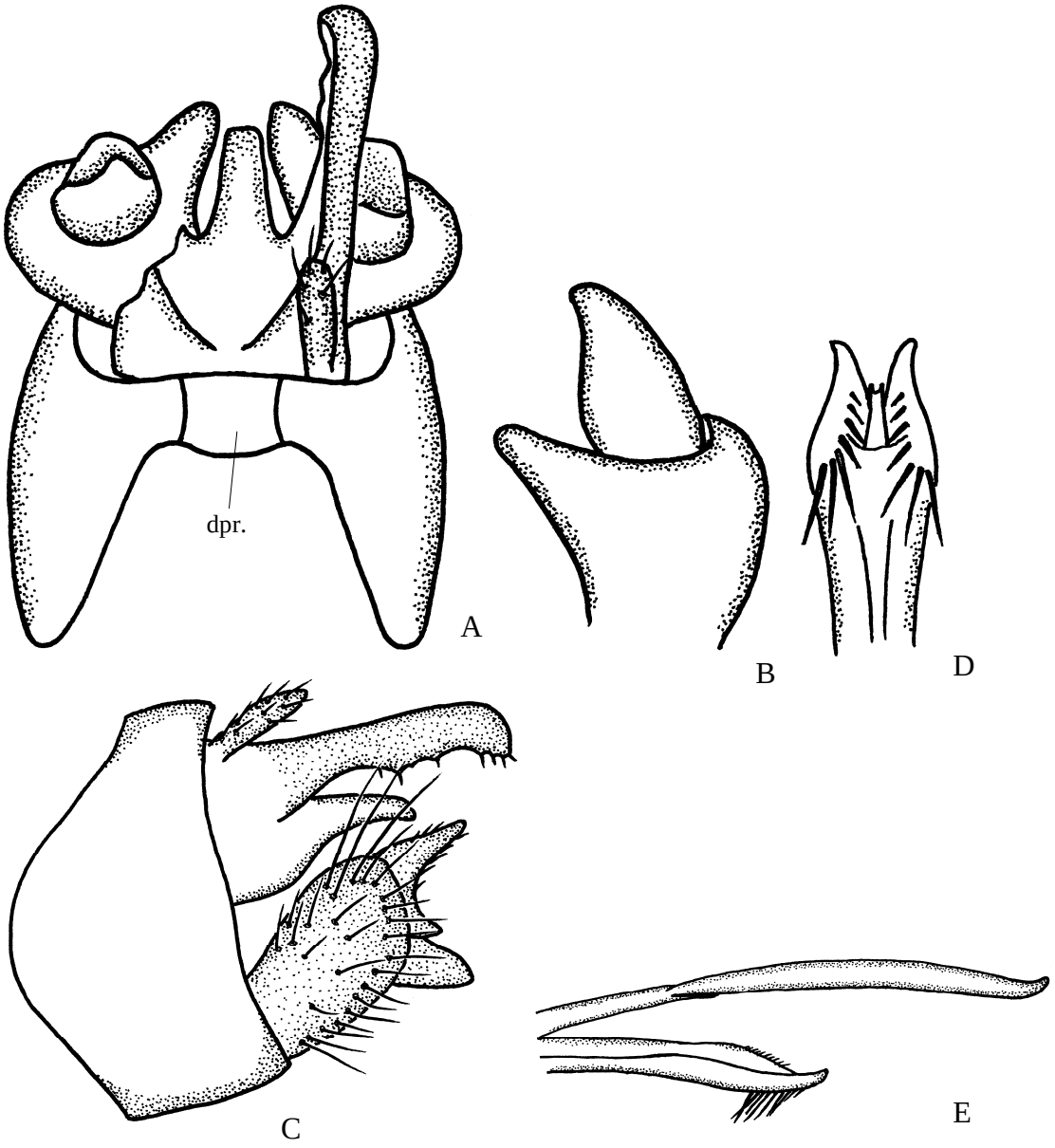


Figure 4.5. Male genitalia of *Apatania zonella* (Zetterstedt). Redrawn from Schmid 1954. A) dorsal view, B) ventral view of harpago, C) left lateral view, D) ventral view of phallicata, E) lateral view of phallus.

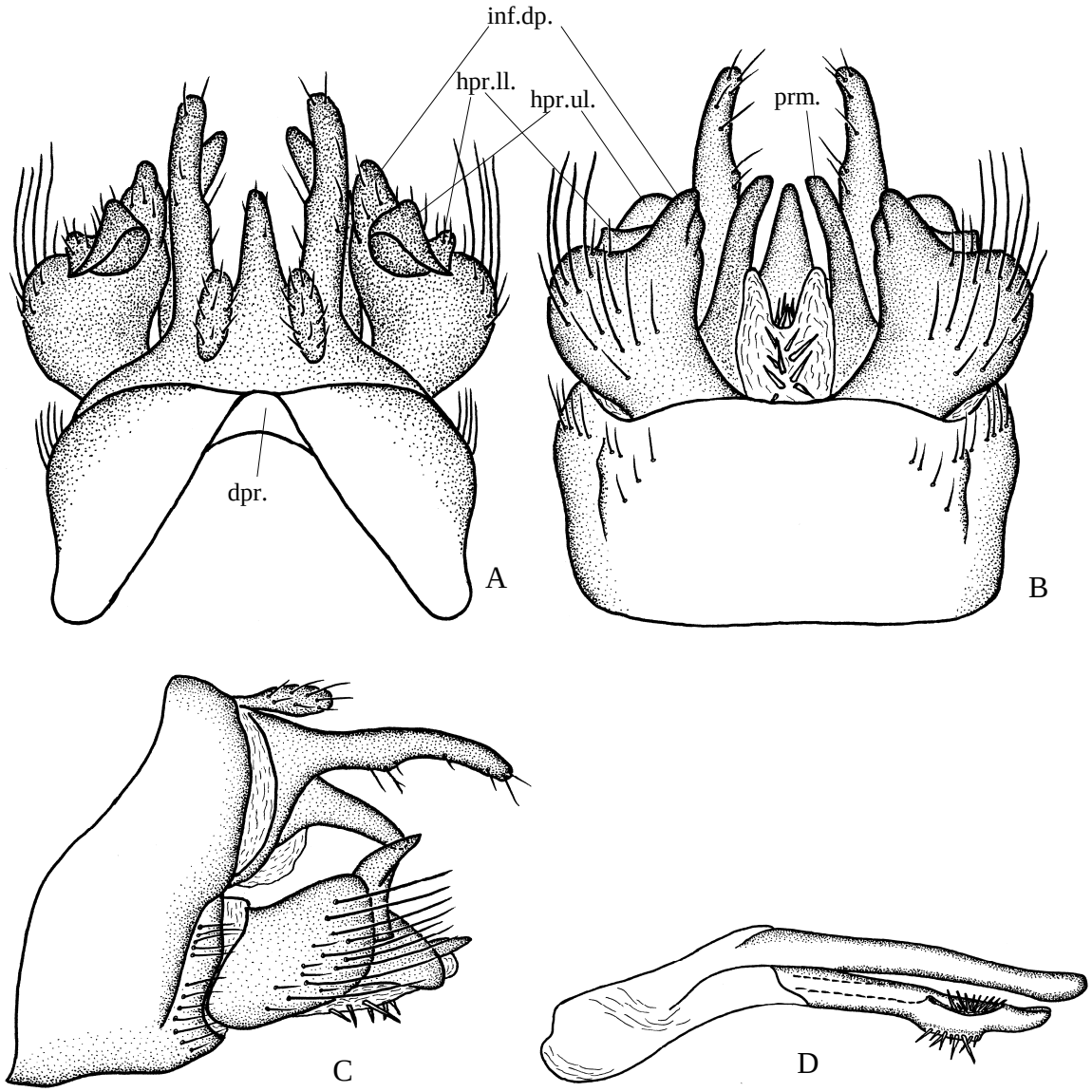


Figure 4.6. Male genitalia of *Apatania dalecarlica* (Forsslund). A) dorsal view, B) ventral, view, phallus *in situ*, C) left lateral view, D) left lateral view of phallus.

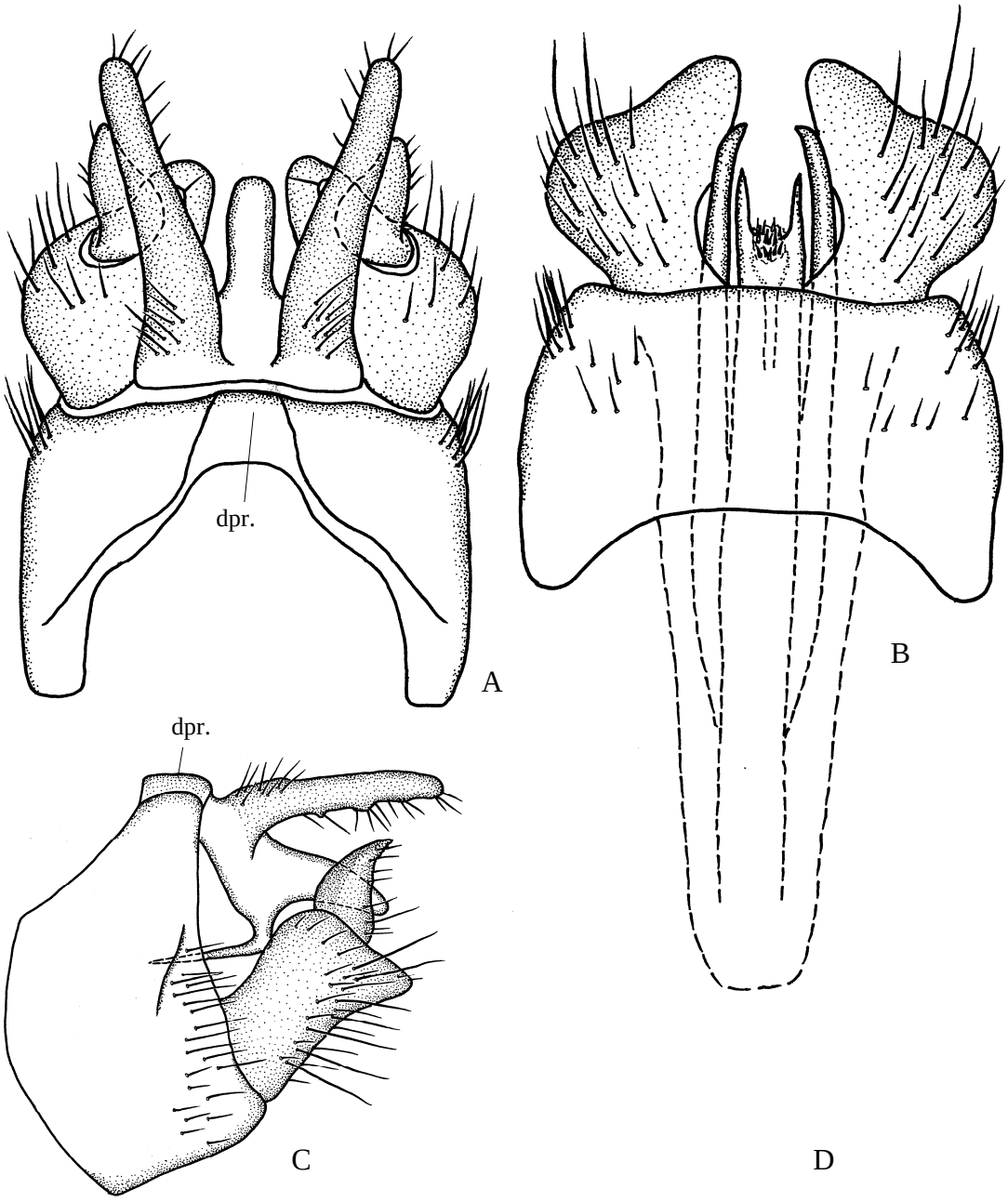


Figure 4.7. Male genitalia of *Apatania nikkoensis* Tsuda. A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, D) left lateral view of phallus.

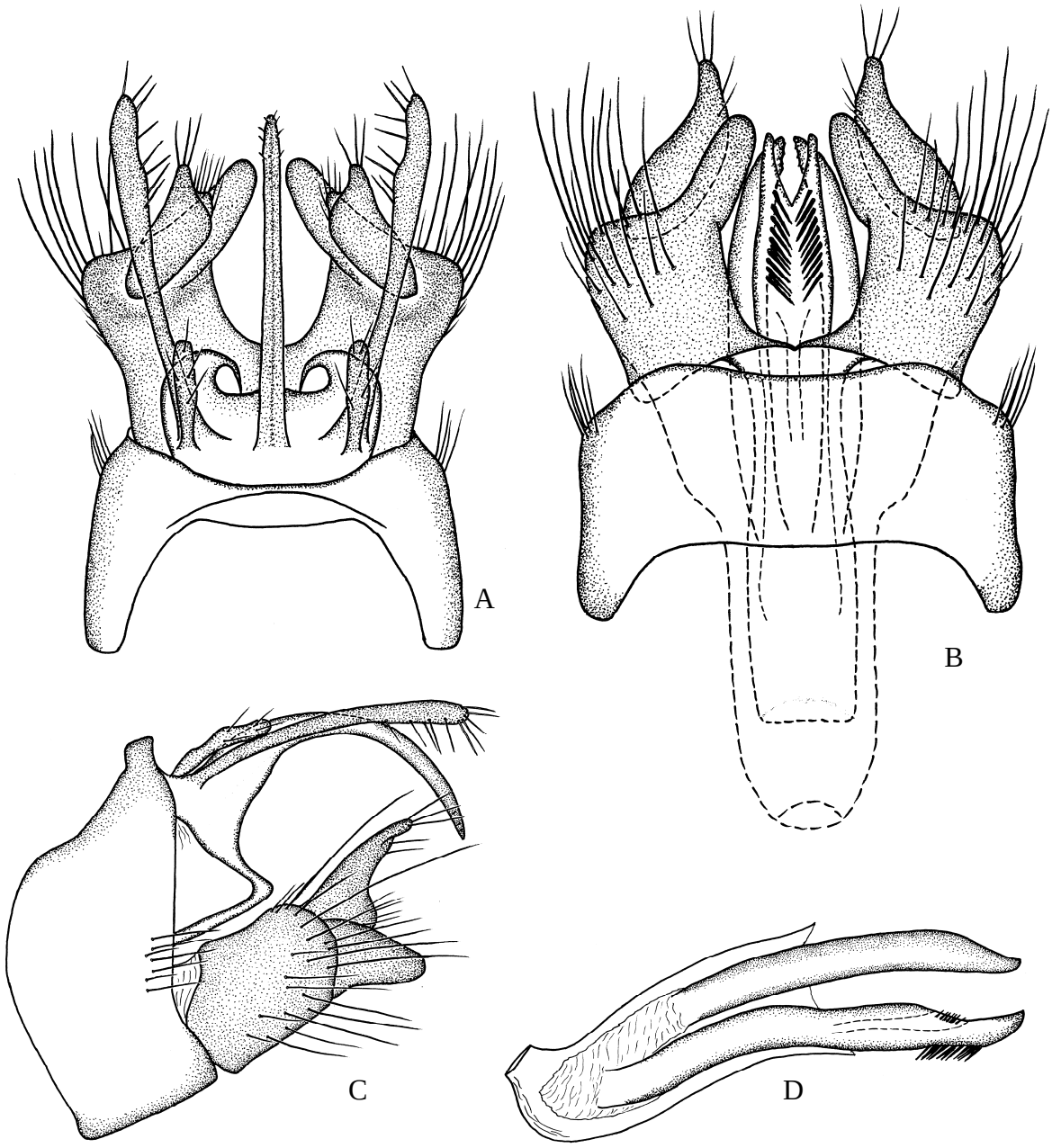


Figure 4.8. Male genitalia of *Apatania majuscula* McLachlan, Hovsgol, Mongolia. A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, D) left lateral view of phallus.

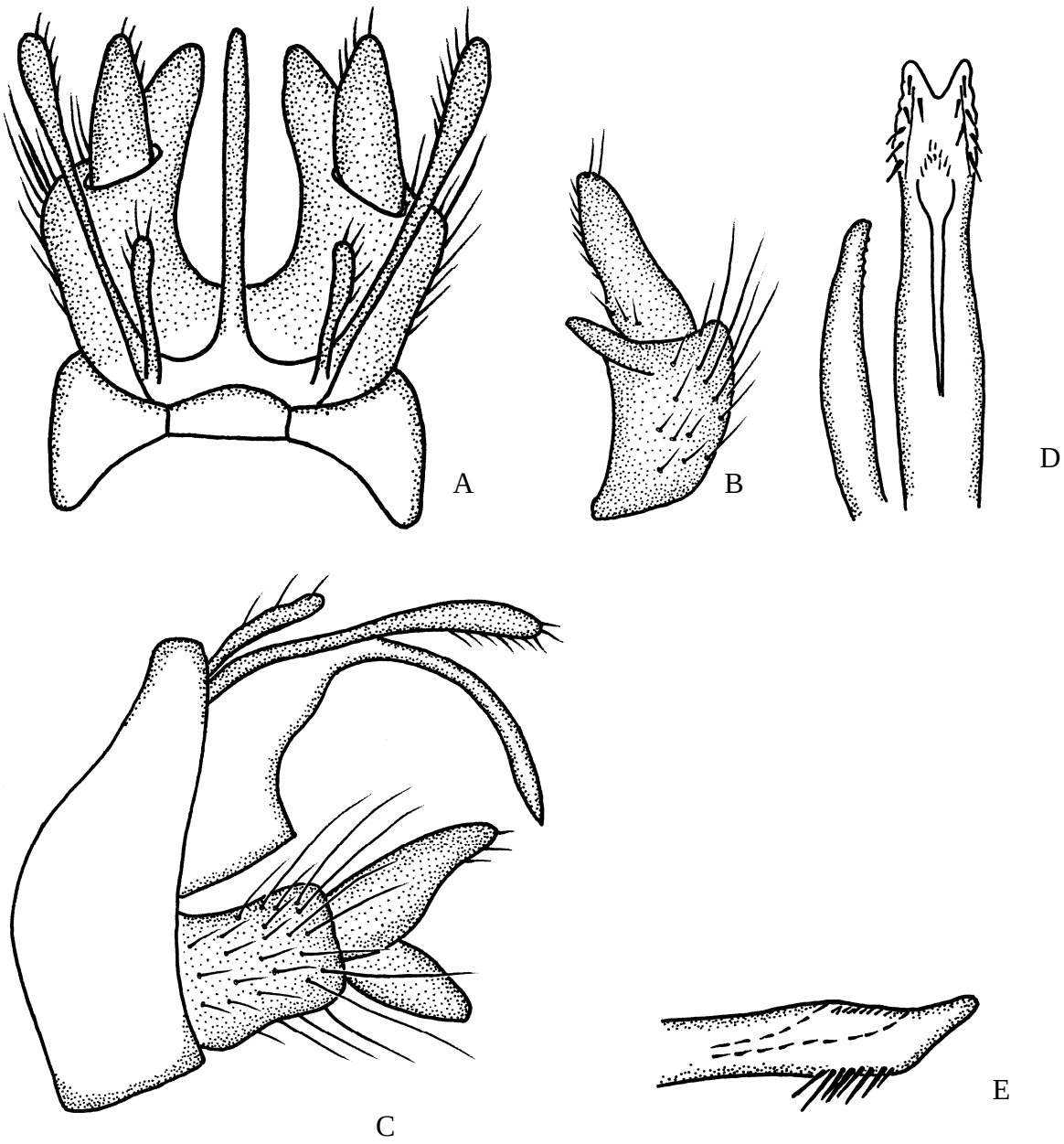


Figure 4.9. Male genitalia of *Apatania majuscula* McLachlan, Bulgan, Mongolia. A) dorsal view, B) ventral view of inferior appendage and harpago, C) left lateral view, D) phallus ventral, E) phallicata apex lateral view.

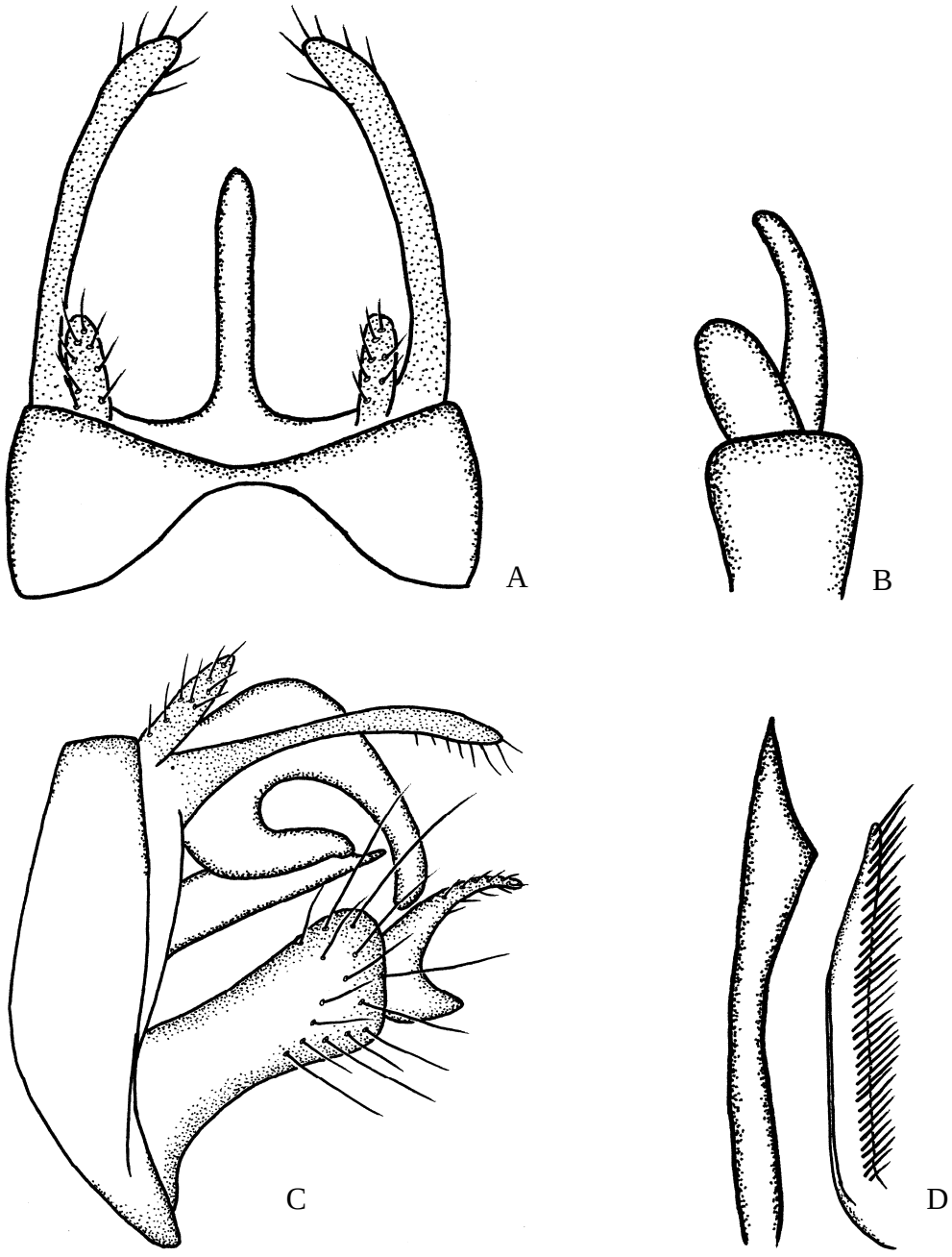


Figure 4.10. Male genitalia of *Apatania mongolica* Martynov. Redrawn from Schmid 1953. A) dorsal view, B) ventral view of inferior appendage, C) lateral view, D) dorsal view of phallus apex.

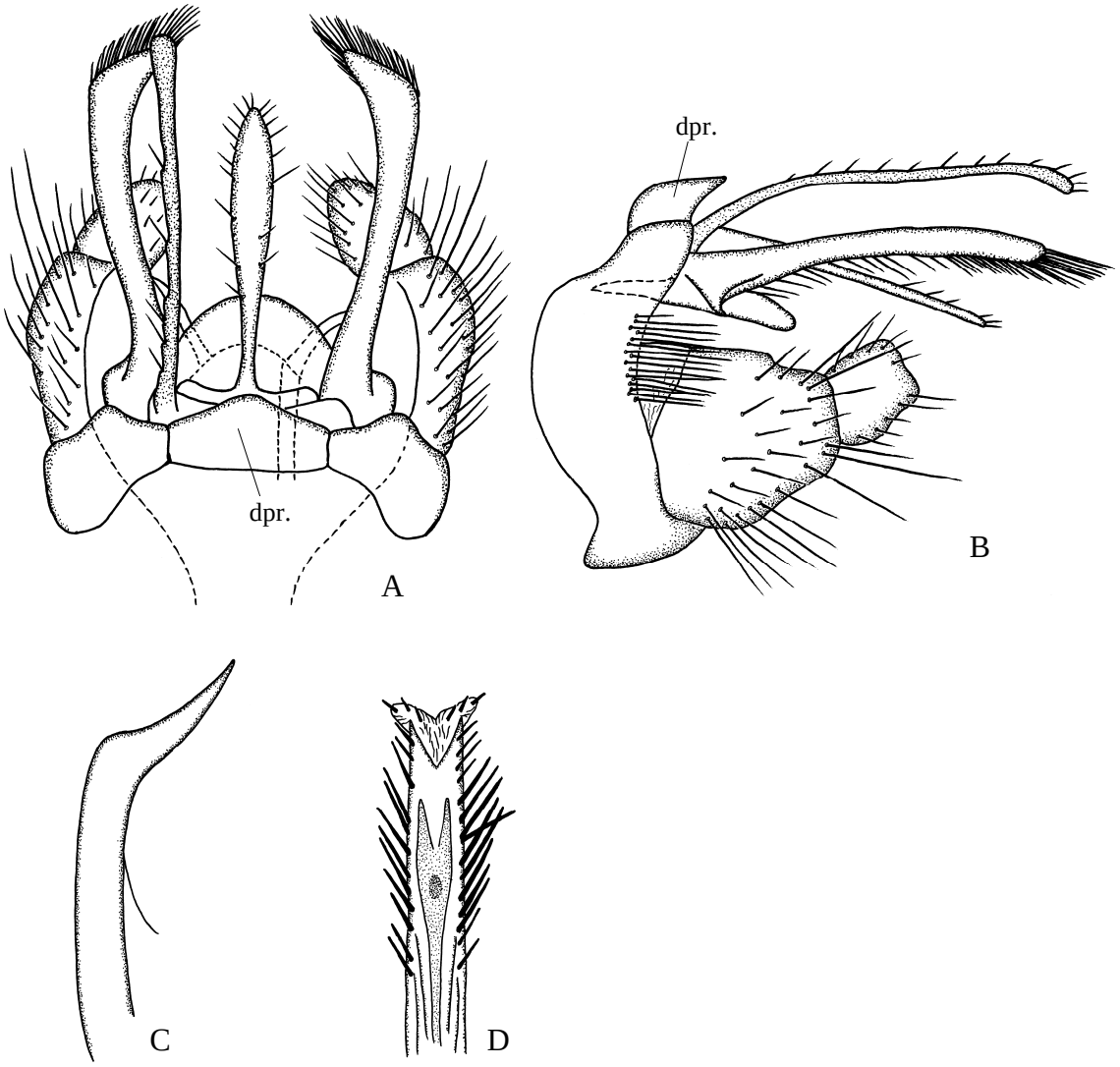


Figure 4.11. Male genitalia of *Apatania copiosa* (McLachlan). Redrawn from Schmid 1954. A) Dorsal view of male genitalia, B) left lateral view of male genitalia, C) dorsal view of paramere, apex, D) dorsal view of phallicata.

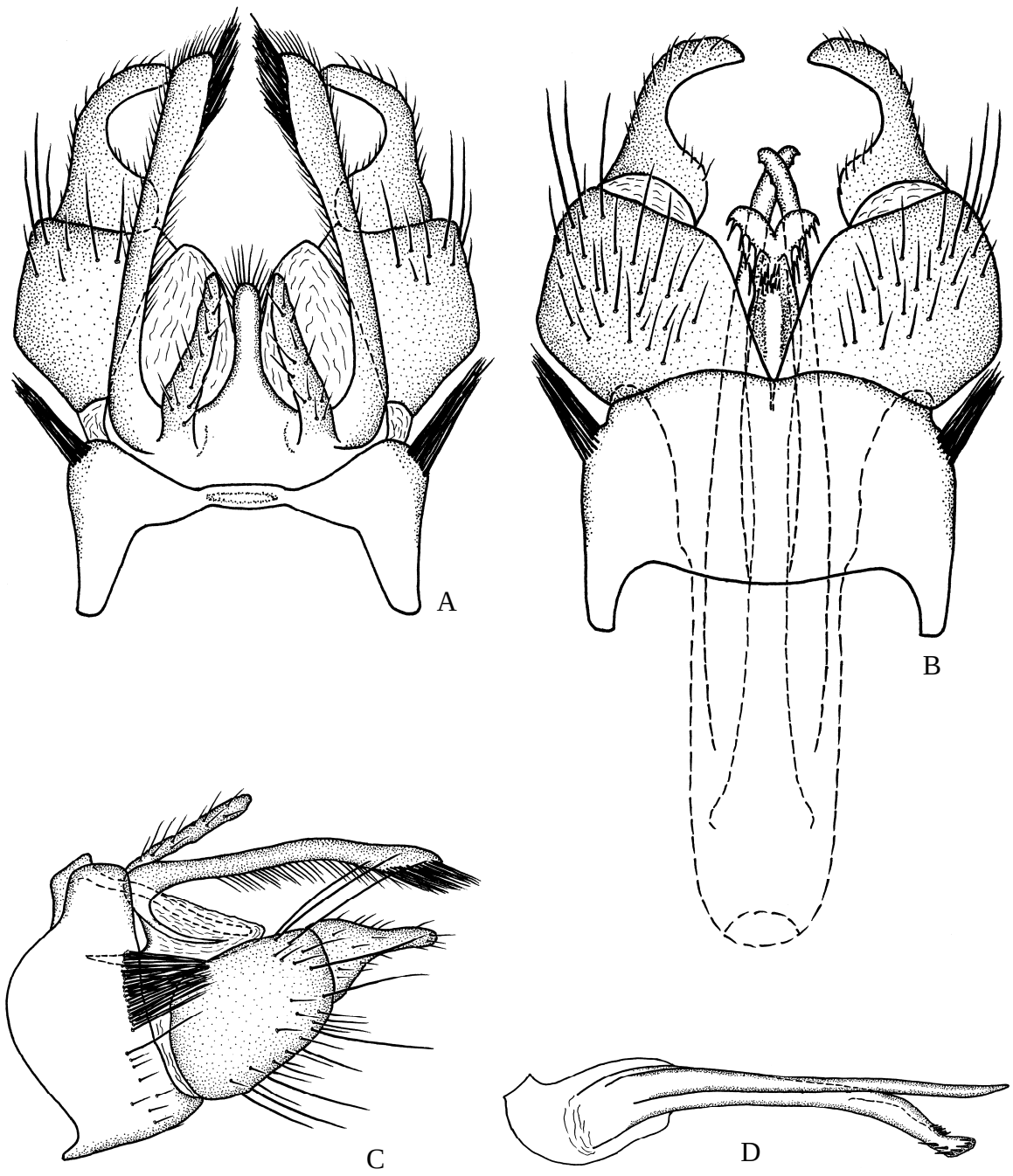


Figure 4.12. Male genitalia of *Apatania hamardabanica* Mey. A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, D) left lateral view of phallic apparatus.

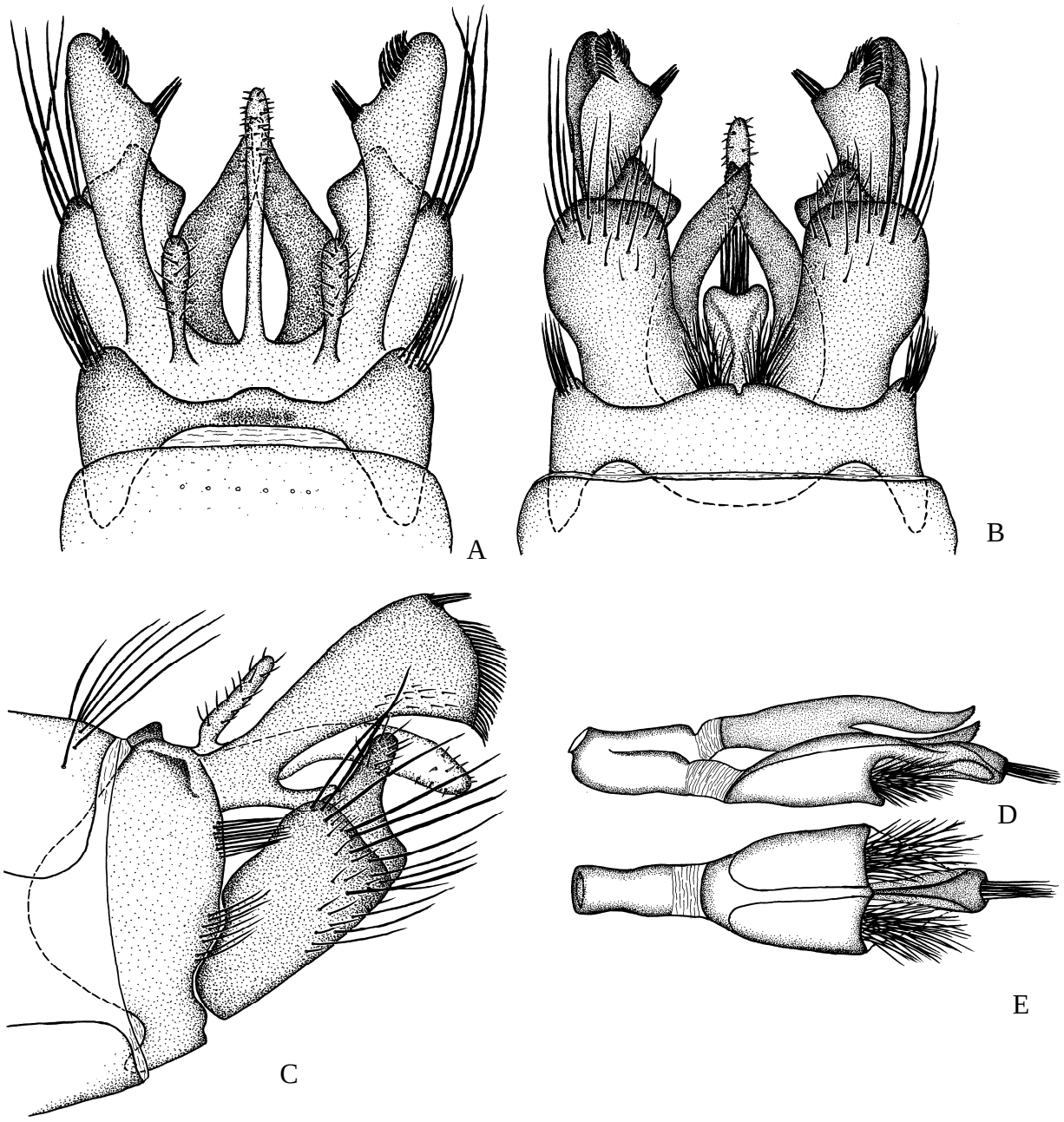


Figure 4.13. Male genitalia of *Apatania sinensis* Martynov. A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, D) left lateral view of phallus, E) ventral view of phallus.

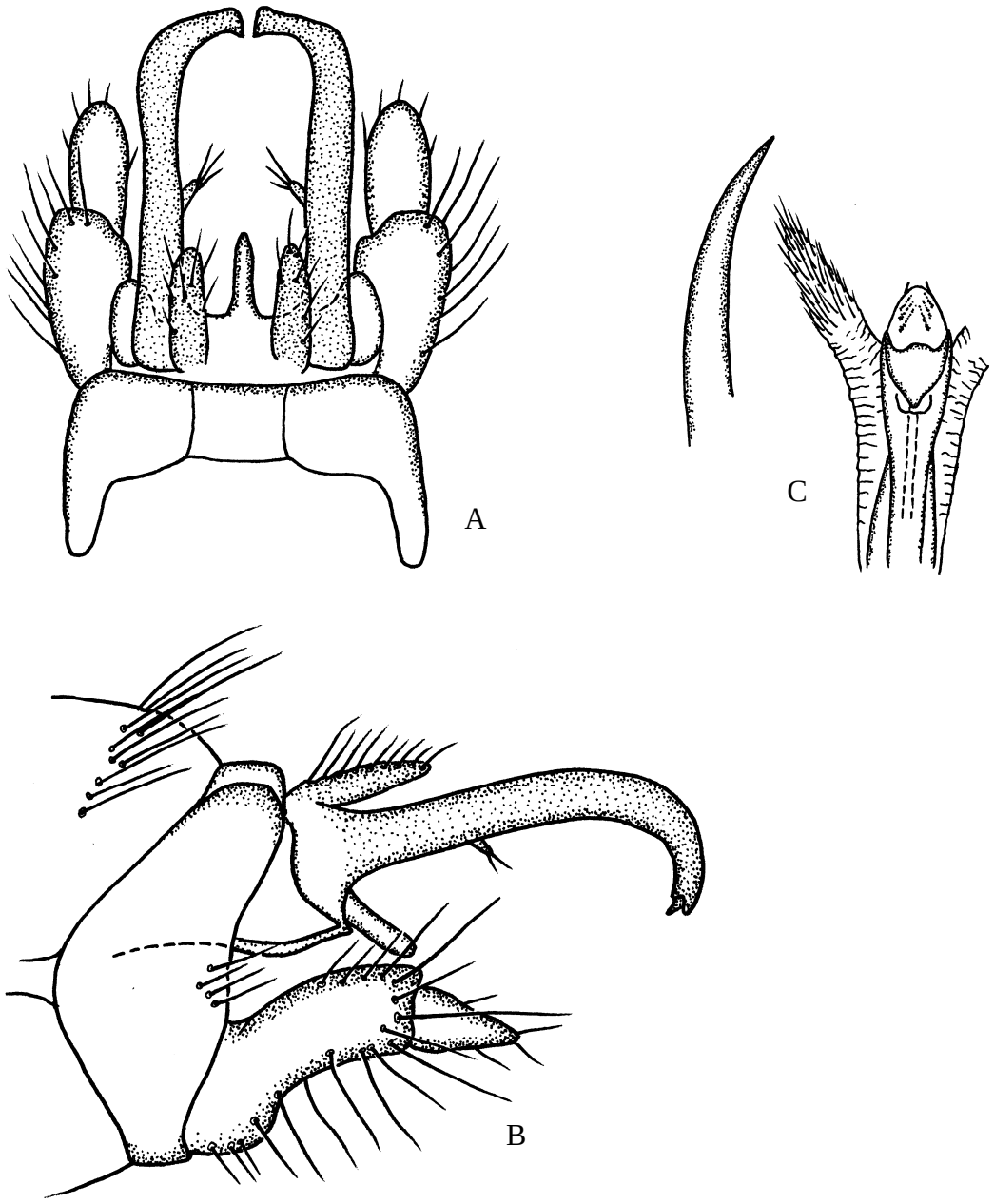


Figure 4.14. Male genitalia of *Apatania ulmeri* Schmid. Redrawn from Schmid 1950. A) dorsal view, B) left lateral view, C) dorsal view of phallus apex.

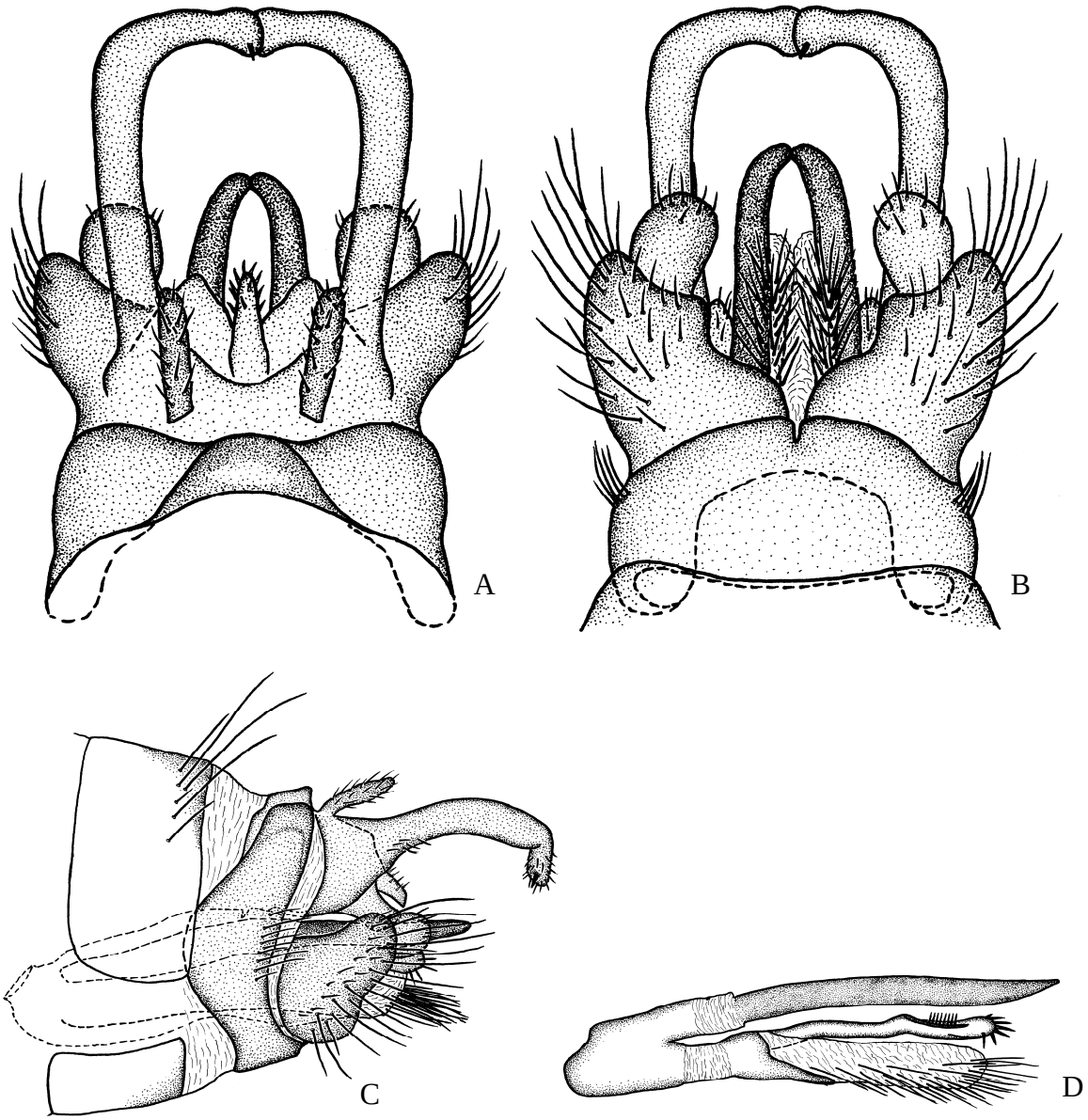


Figure 4.15. Male genitalia of *Apatania maritima* Ivanov. A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, D) left lateral view of phallus.

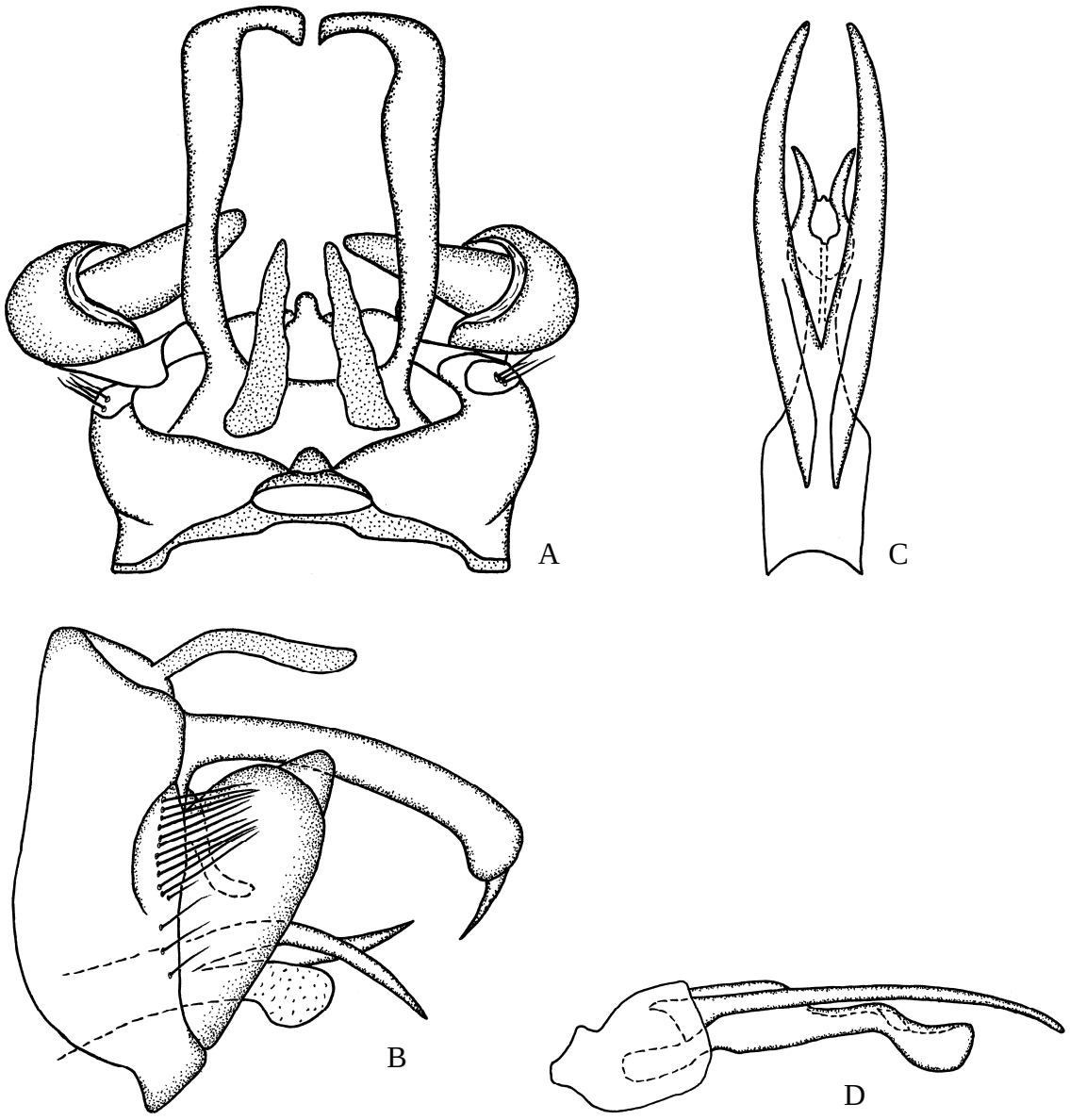


Figure 4.16. Male genitalia of *Apatania sarkandensis* Ivanov. Redrawn from Ivanov 1991. A) dorsal view, B) left lateral view C) dorsal view of phallus, D) lateral view of phallus.

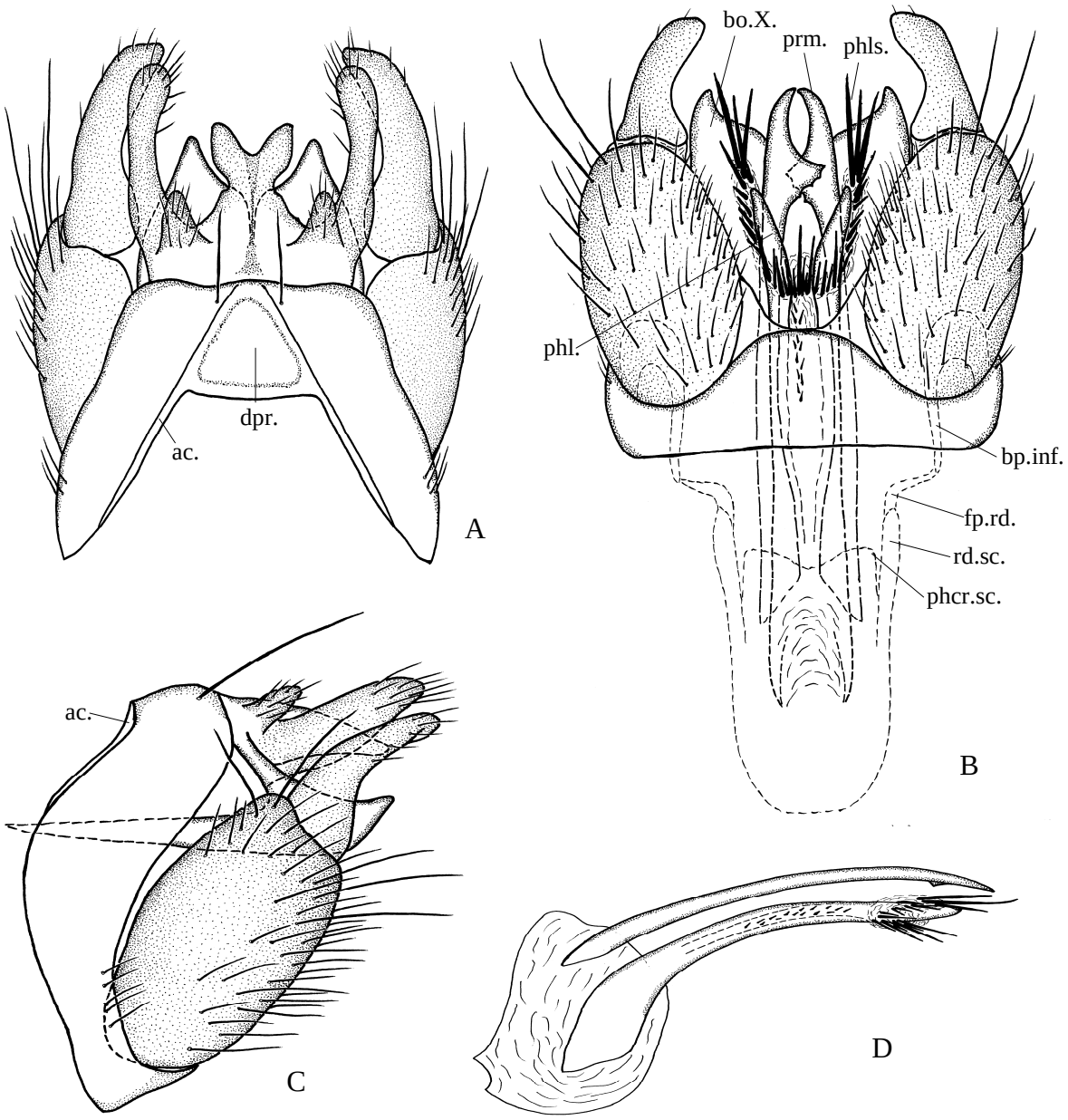


Figure 4.17. Male genitalia of *Apatania chokaiensis* Kobayashi. A) dorsal view, B) ventral view of genitalia, phallus *in situ* C) left lateral view, D) left lateral view of phallus.

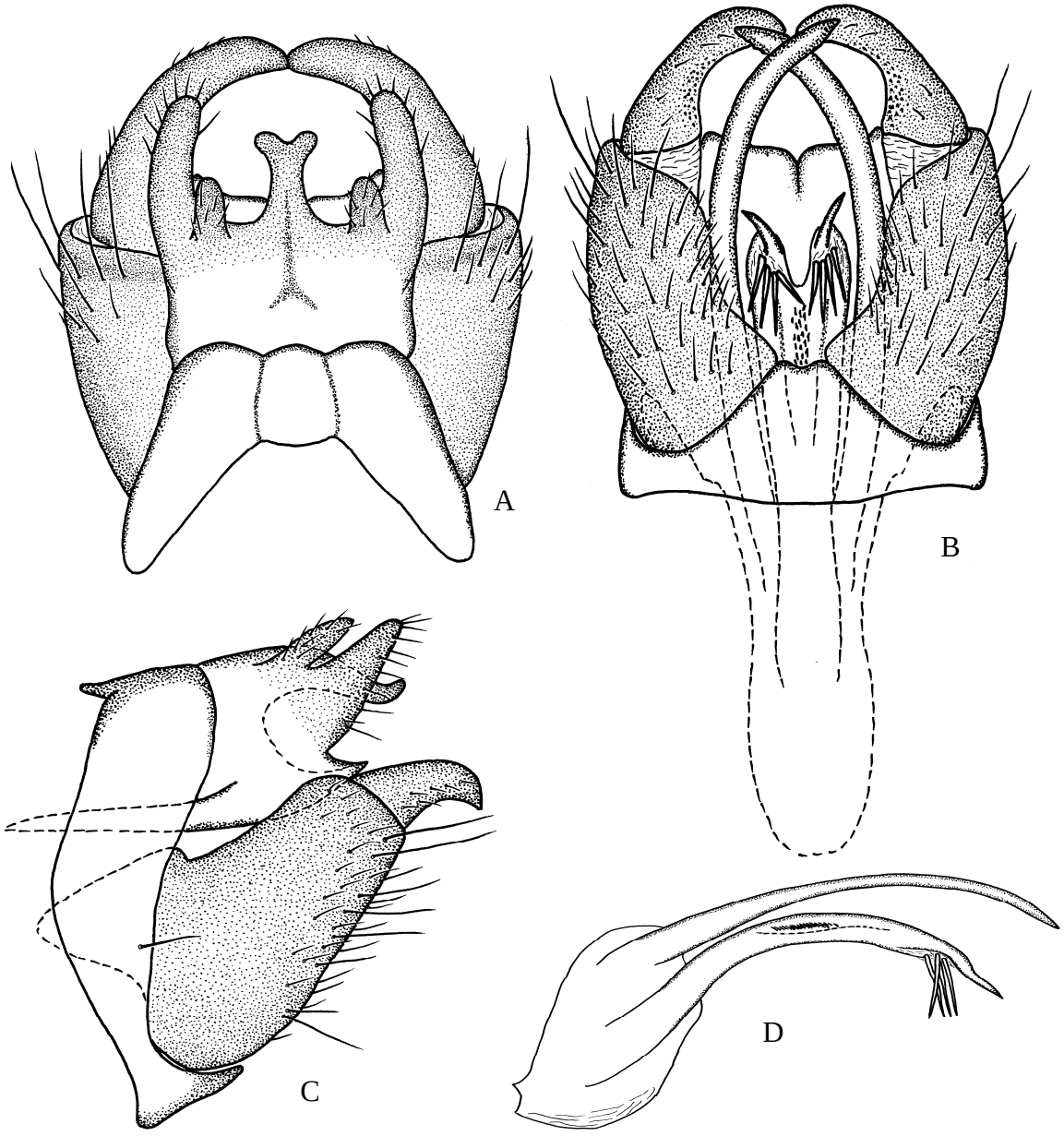


Figure 4.18. Male genitalia of *Apatania ishikawai* Schmid. A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, D) left lateral view of phallus.

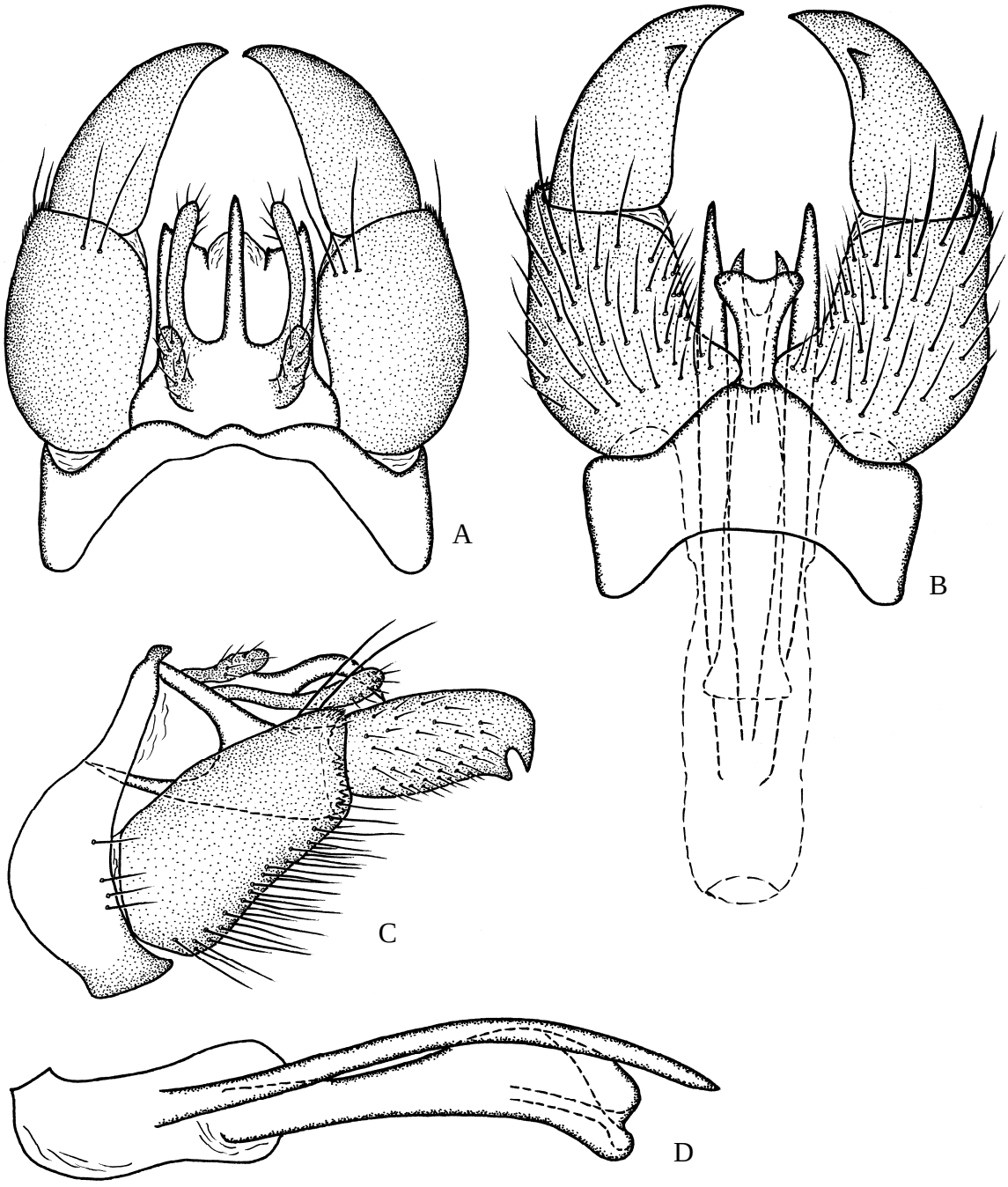


Figure 4.19. Male genitalia of *Apatania parvula* Martynov, Kurile Island, Russia. A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, D) left lateral view of phallus.

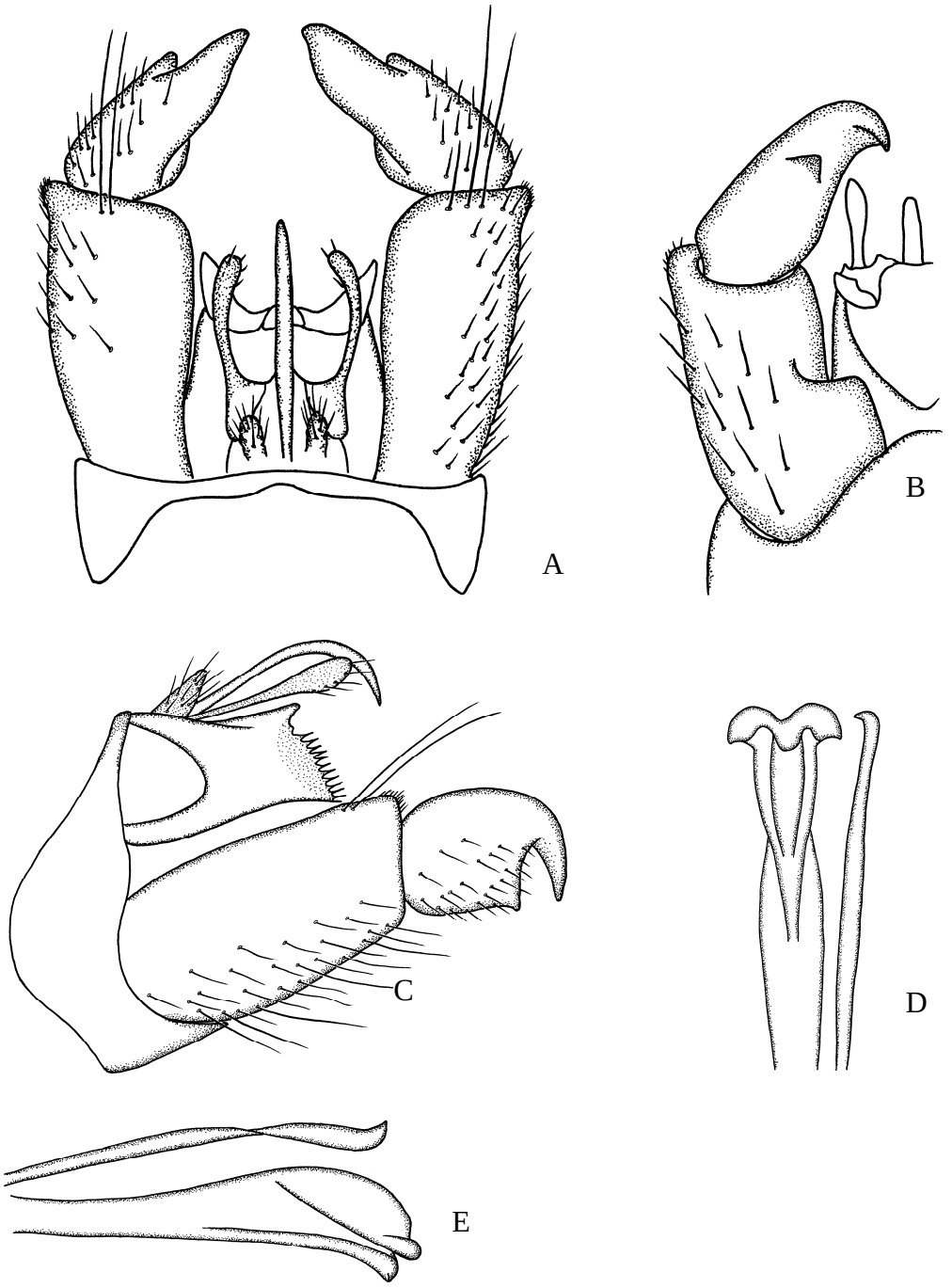


Figure 4.20. Male genitalia of *Apatania parvula* Martynov, Sapporo, Japan. Redrawn from Schmid 1953. A) dorsal view, B) ventral view, C) left lateral view, D) dorsal view of phallus apex, E) left lateral view of phallus, apex.

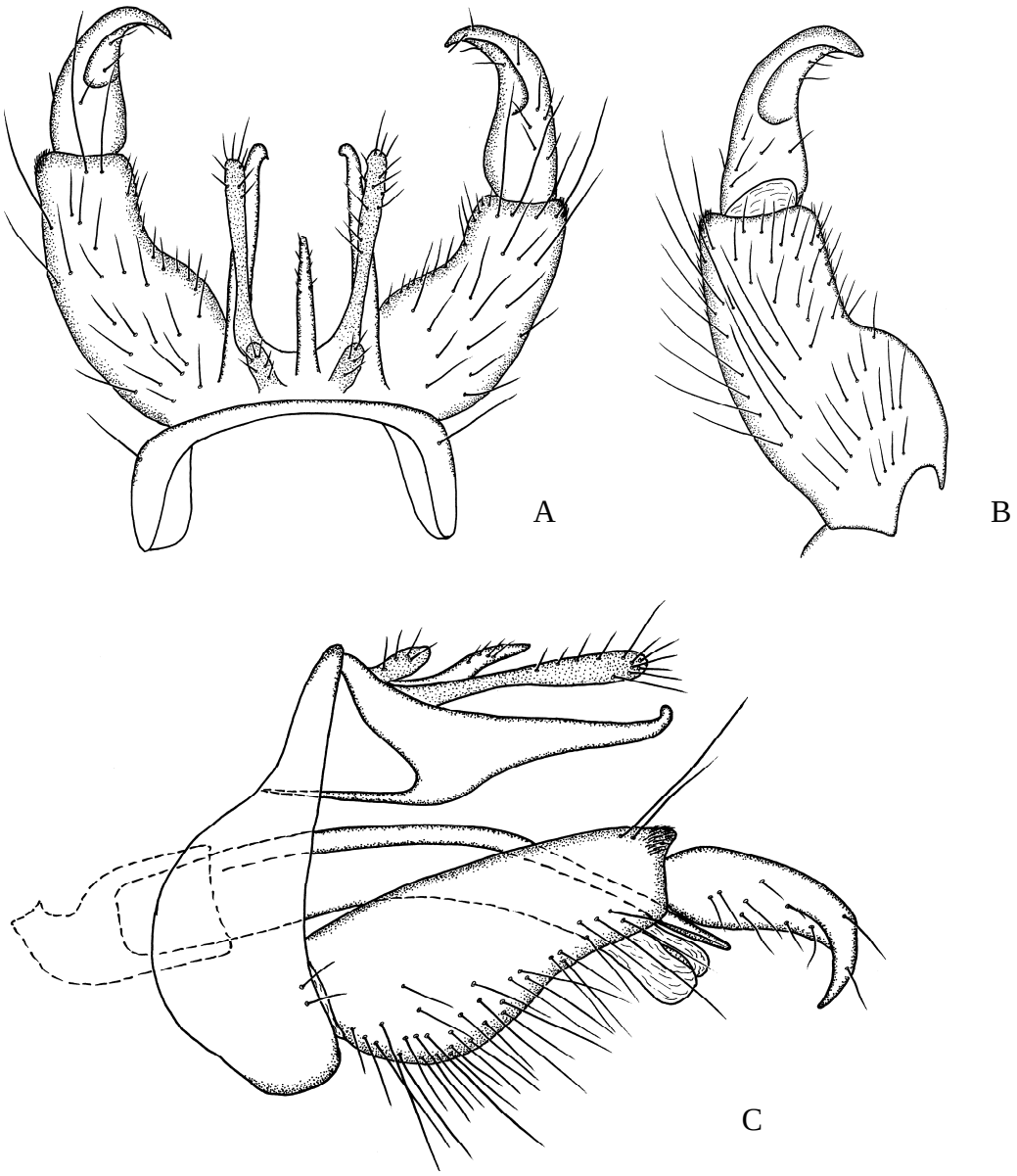


Figure 4.21. Male genitalia of *Apatania insularis* Levanidova. Redrawn from Levanidova 1979. A) dorsal view, B) ventral view, C) left lateral view, phallus *in situ*.

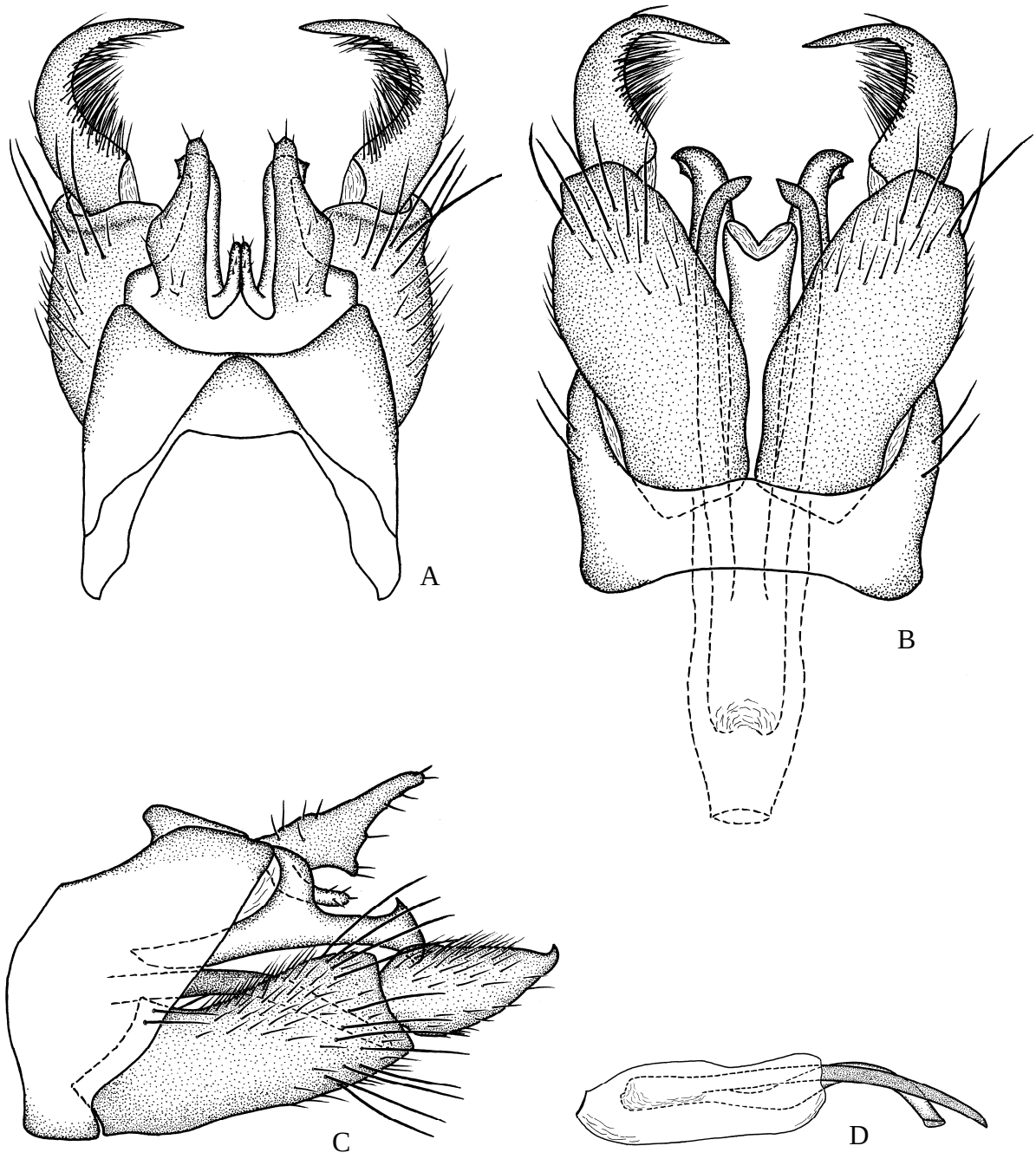


Figure 4.22. Male genitalia of *Apatania stigmatella* (Zetterstedt). A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, D) left lateral view of phallus.

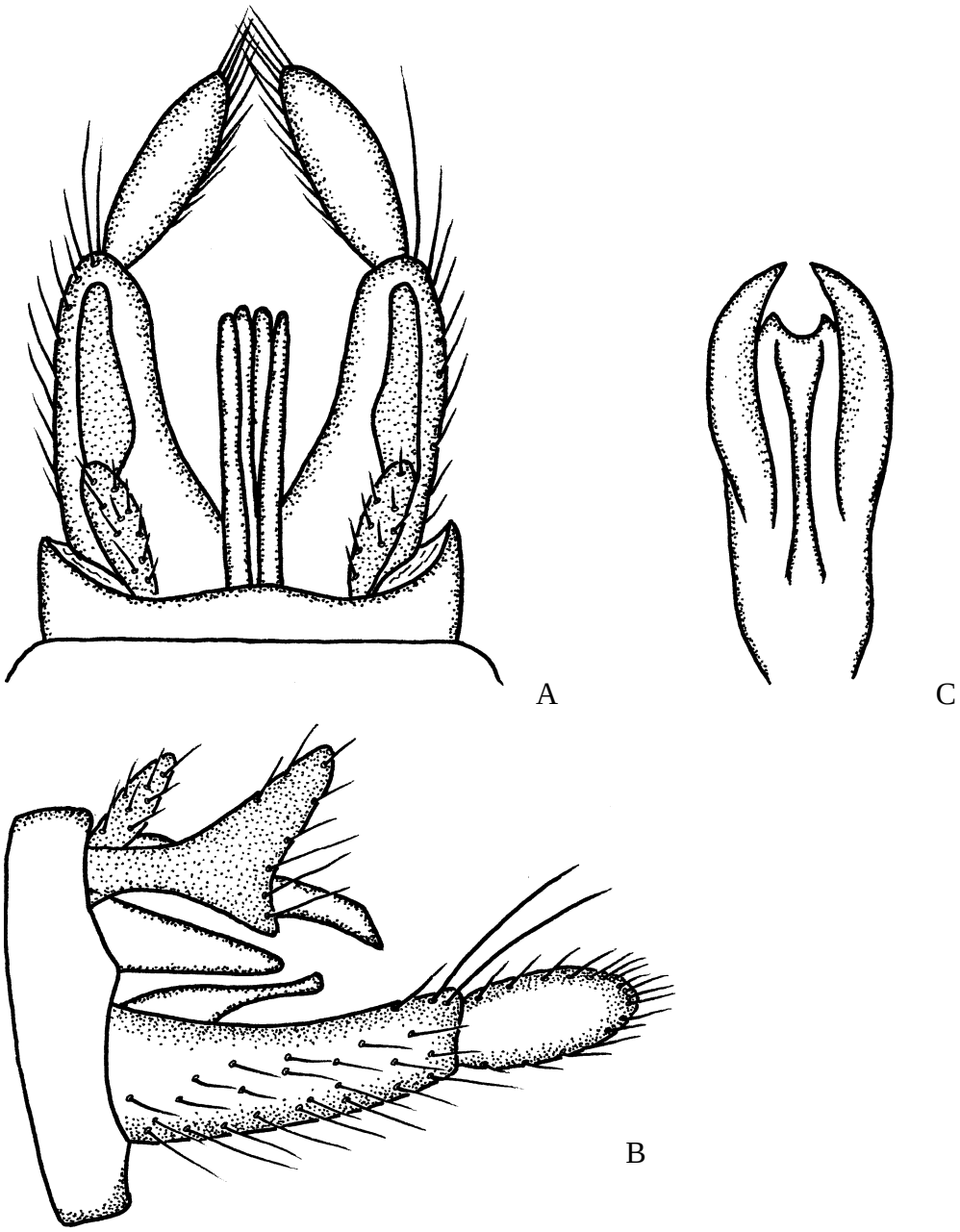


Figure 4.23. Male genitalia of *Apatania mirabilis* Martynov. Redrawn from Schmid 1953. A) dorsal view, B) left lateral view of genitalia, C) dorsal view of phallus.

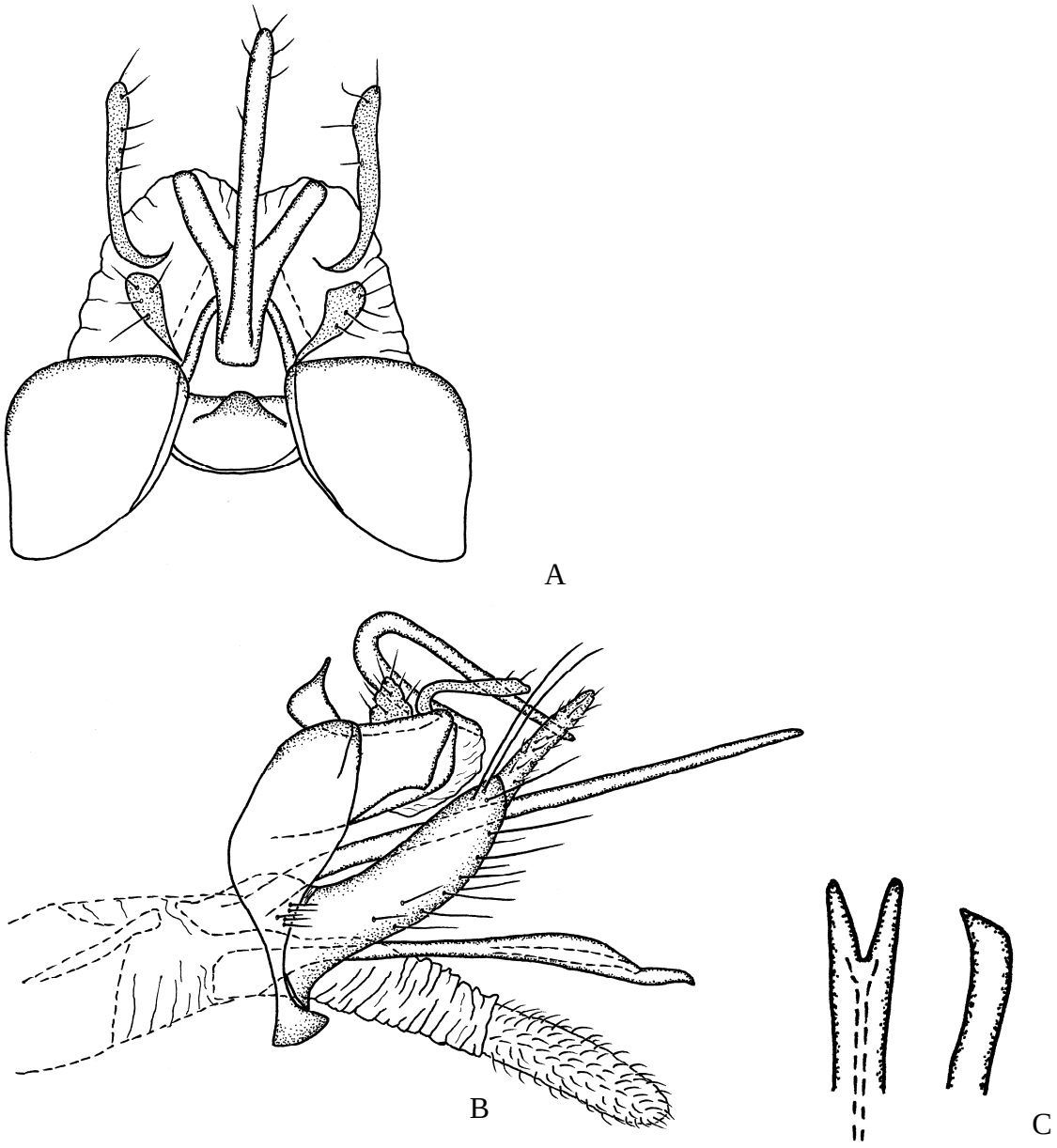


Figure 4.24. Male genitalia of *Apatania siniaevi* Mey and Yang. Redrawn from Mey and Yang 2001. A) dorsal view, B) lateral view, phallus *in situ*, C) dorsal view of phallus apex.

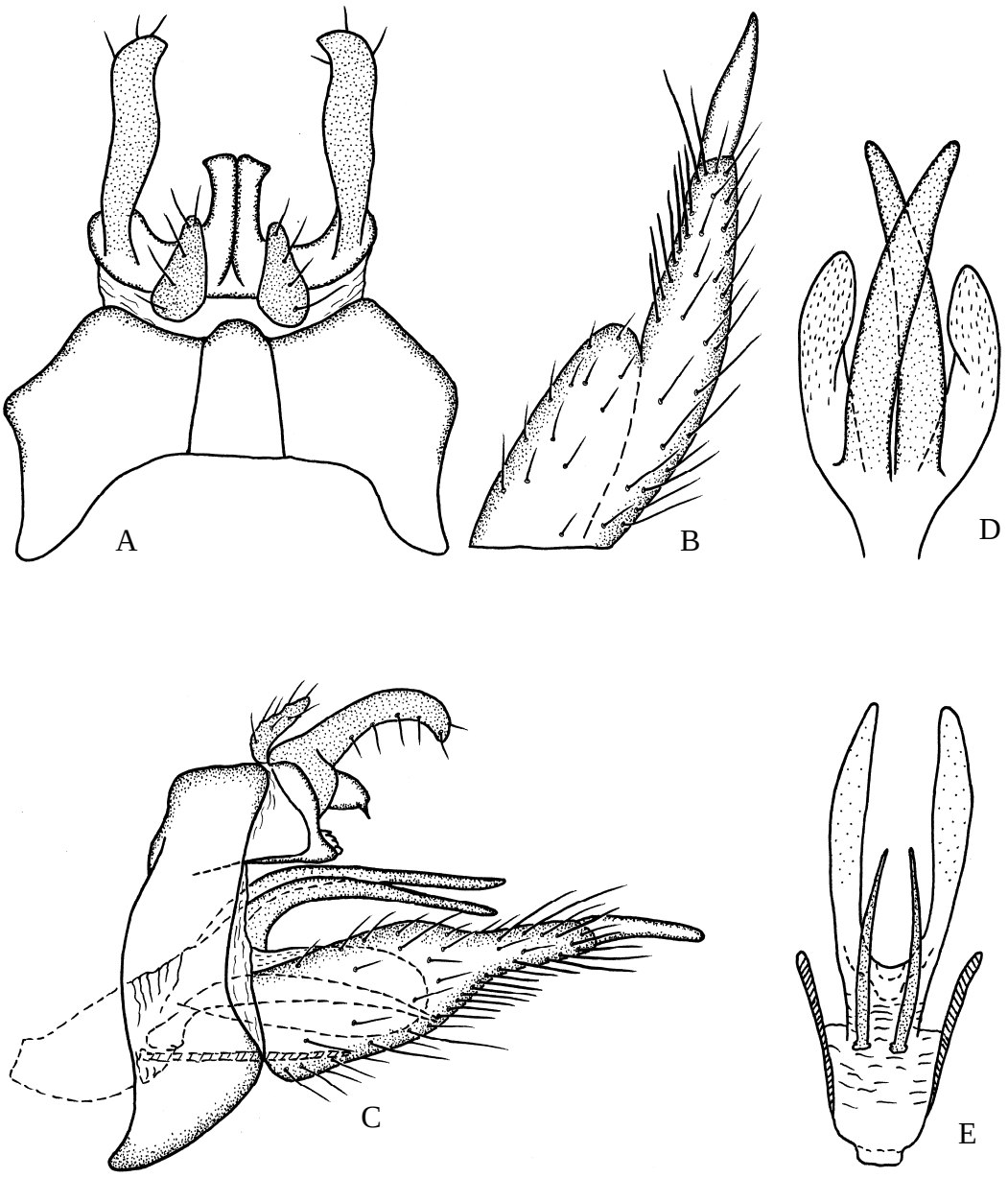


Figure 4.25. Male genitalia of *Apatania pectinella* Mey and Yang. Redrawn from Mey and Yang 2001. A) dorsal view, B) ventral view, C) left lateral view, phallus *in situ*, D) dorsal view of parameres, E) ventral view of phallicata.

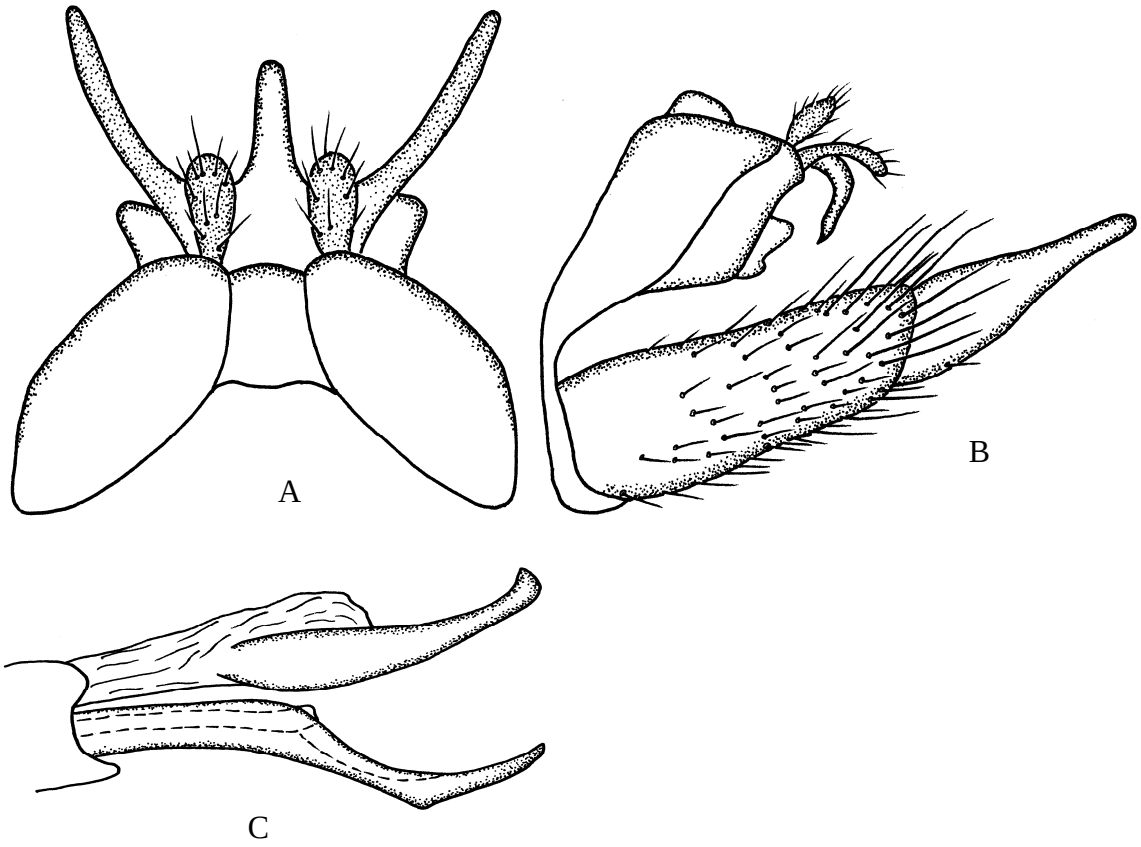


Figure 4.26. Male genitalia of *Apatania yenchingensis* Ulmer. Redrawn from Schmid 1953. A) dorsal view B) left lateral view, C) left lateral view of phallus.

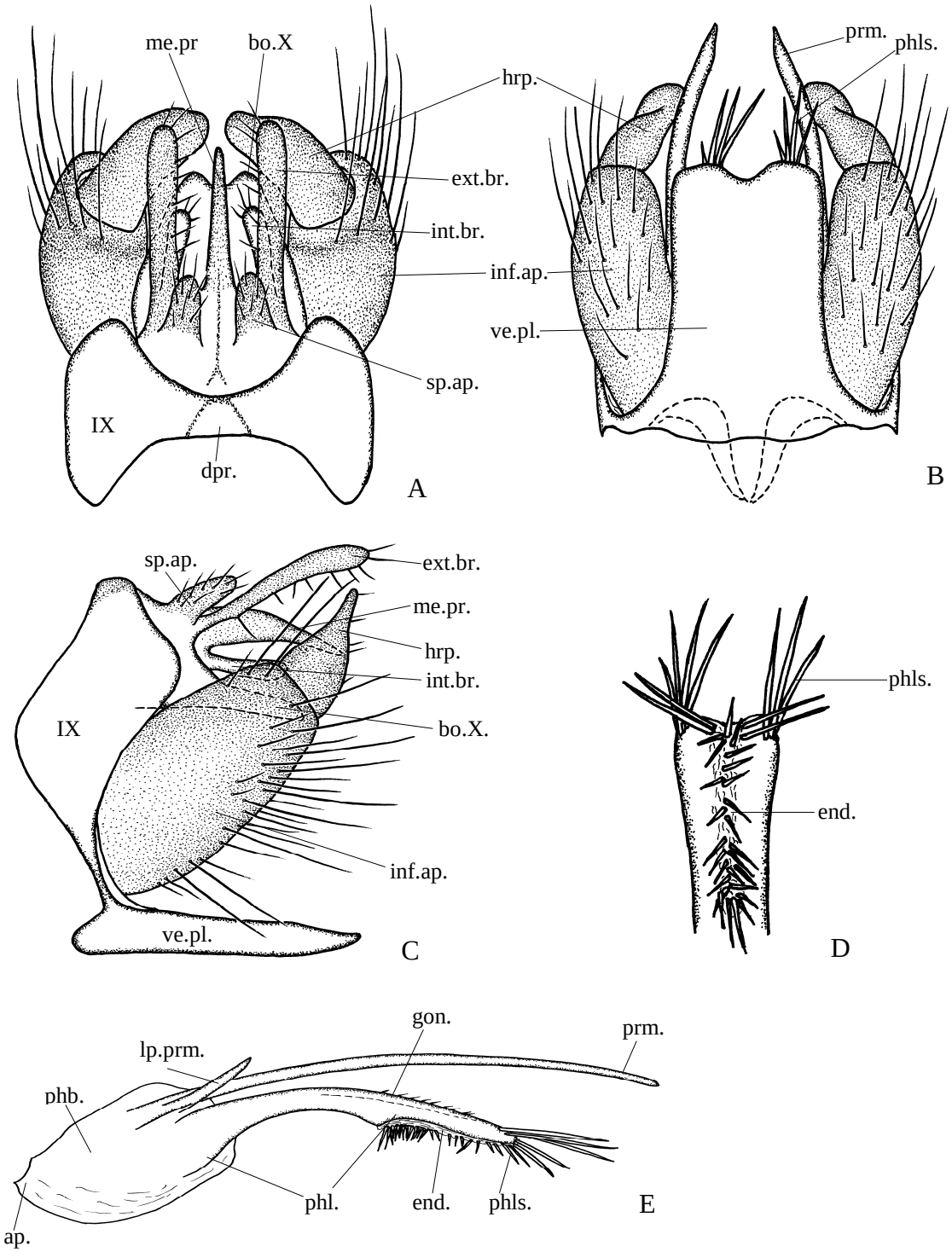


Figure 4.27. Male genitalia of *Apatania aberrans* Martynov. A) dorsal view, B) ventral view, C) left lateral view, D) ventral view of phallicata, apex, E) lateral view of phallus.

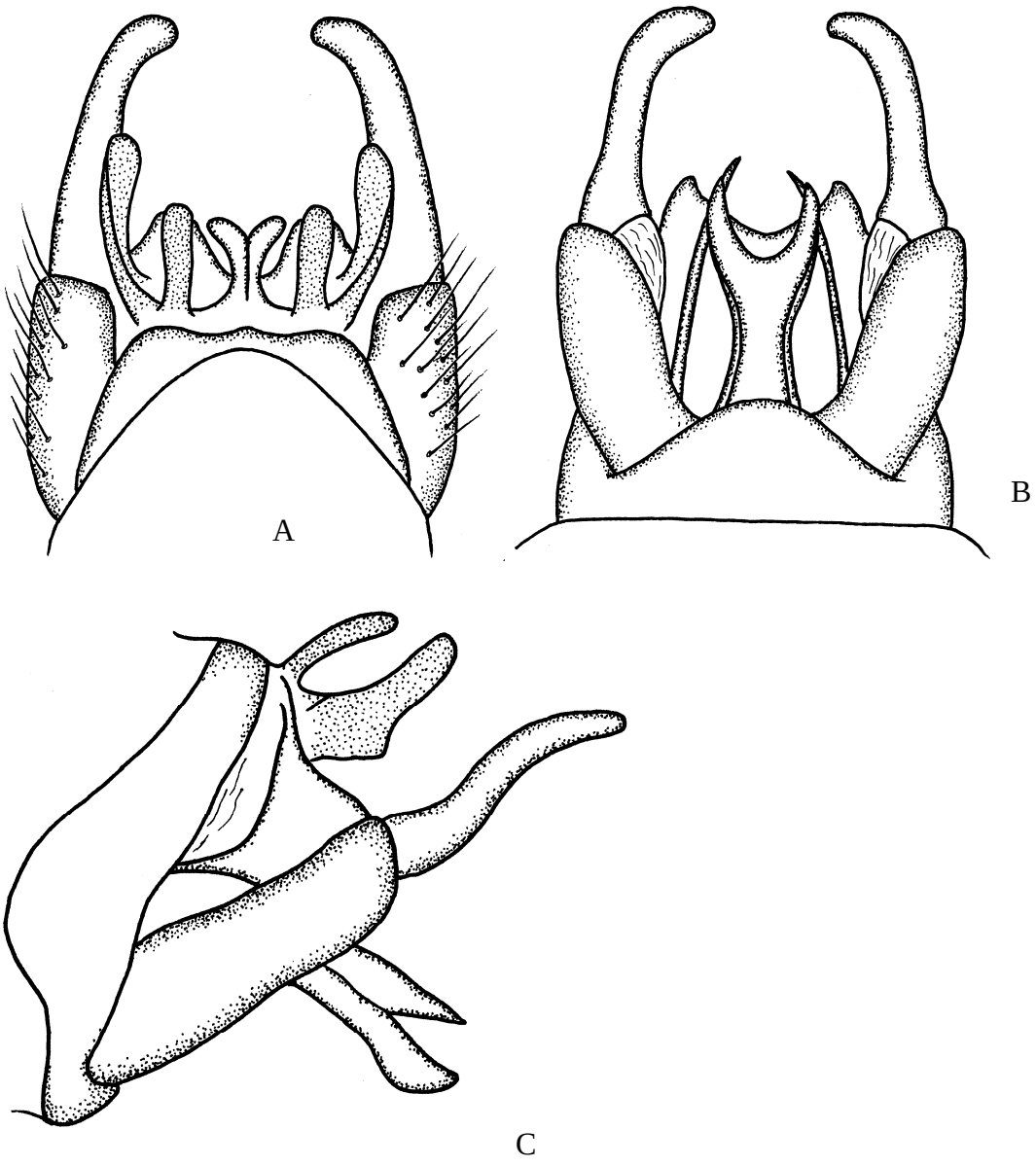


Figure 4.28. Male genitalia of *Apatania shirahatai* Kobayashi. Redrawn from Kobayashi 1973. A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, phallus *in situ*.

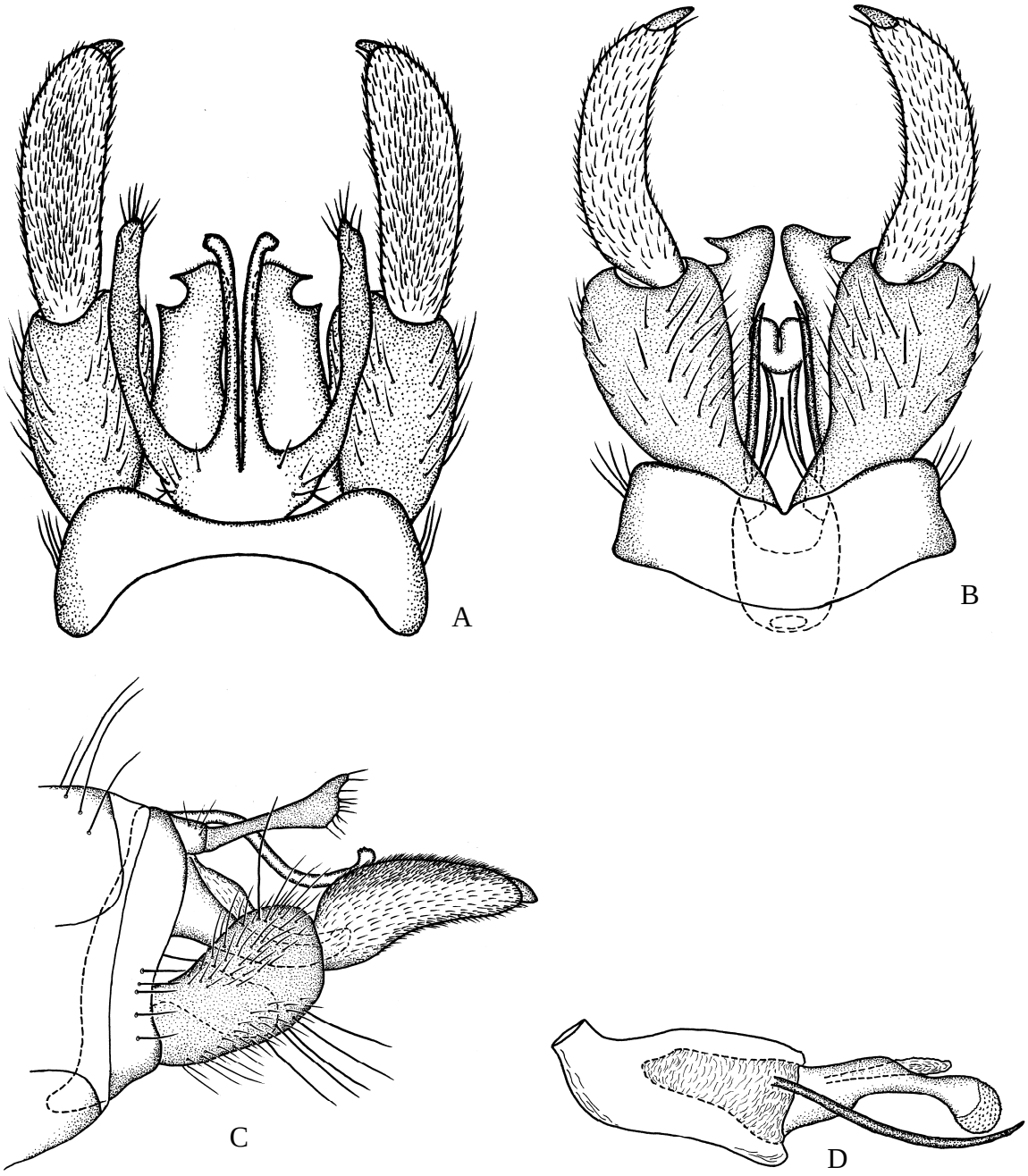


Figure 4.29. Male genitalia of *Apatania crymophila* McLachlan. A) dorsal view, B) ventral view, phallus *in situ* C) left lateral view, D) left lateral view of phallus.

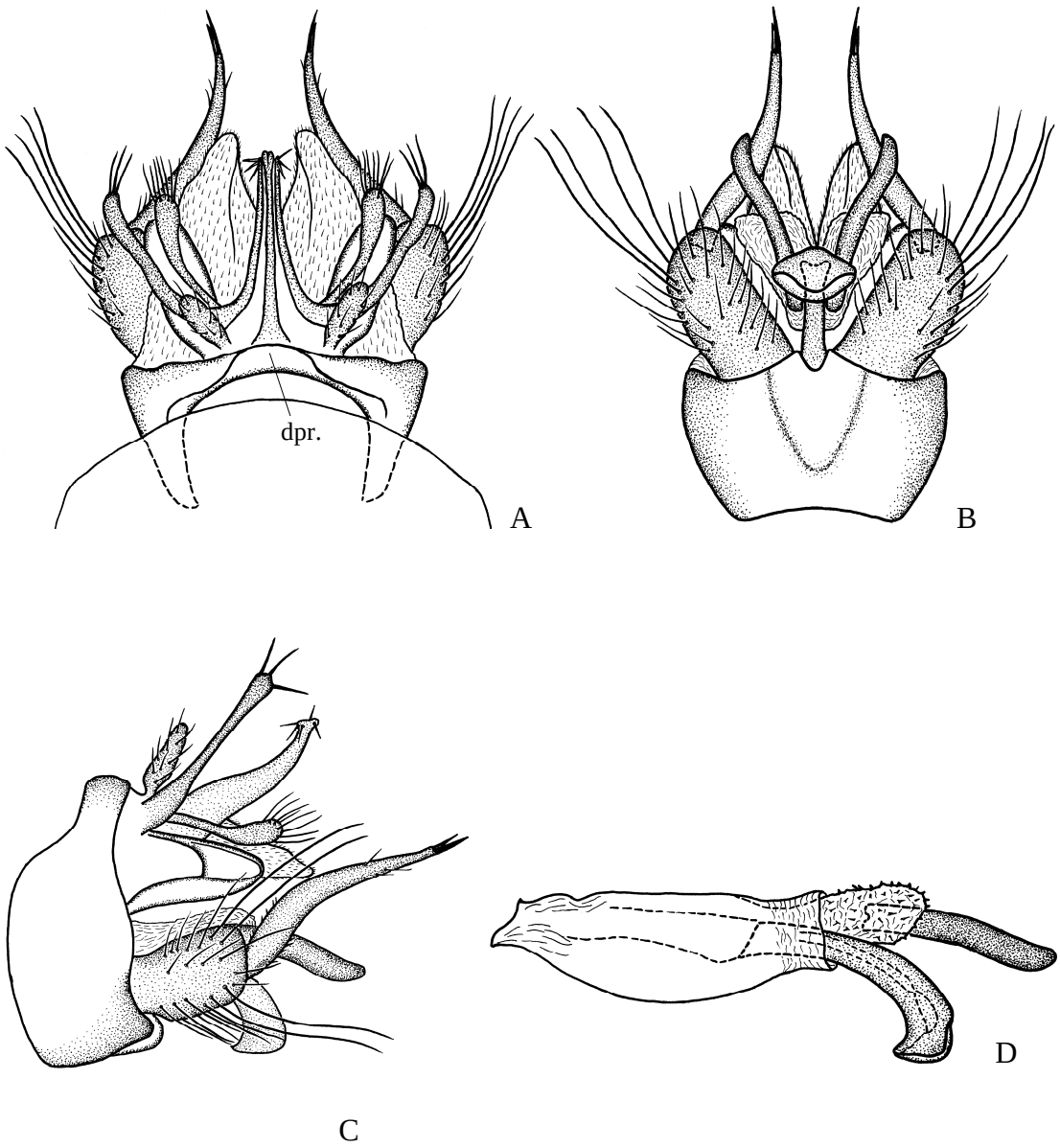


Figure 4.30. Male genitalia of *Apatania complexa* (Martynov). A) dorsal view, B) ventral view, phallus *in situ*, C) left lateral view, phallus *in situ*, D) left lateral view of phallus.

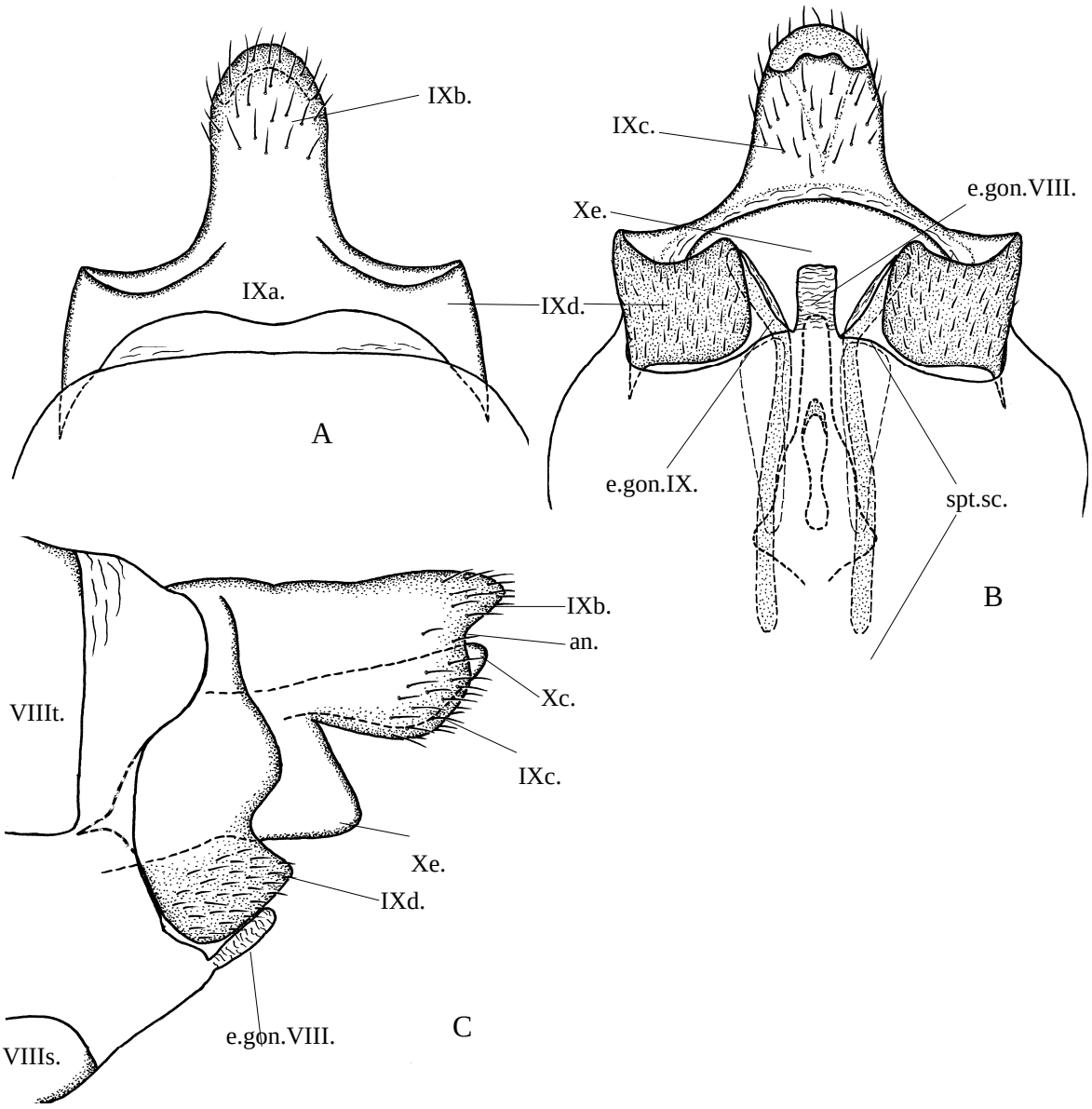


Figure 4.31. Female genitalia of *Apatania tsudai* Schmid. A) dorsal view, B) ventral view, C) left lateral view.

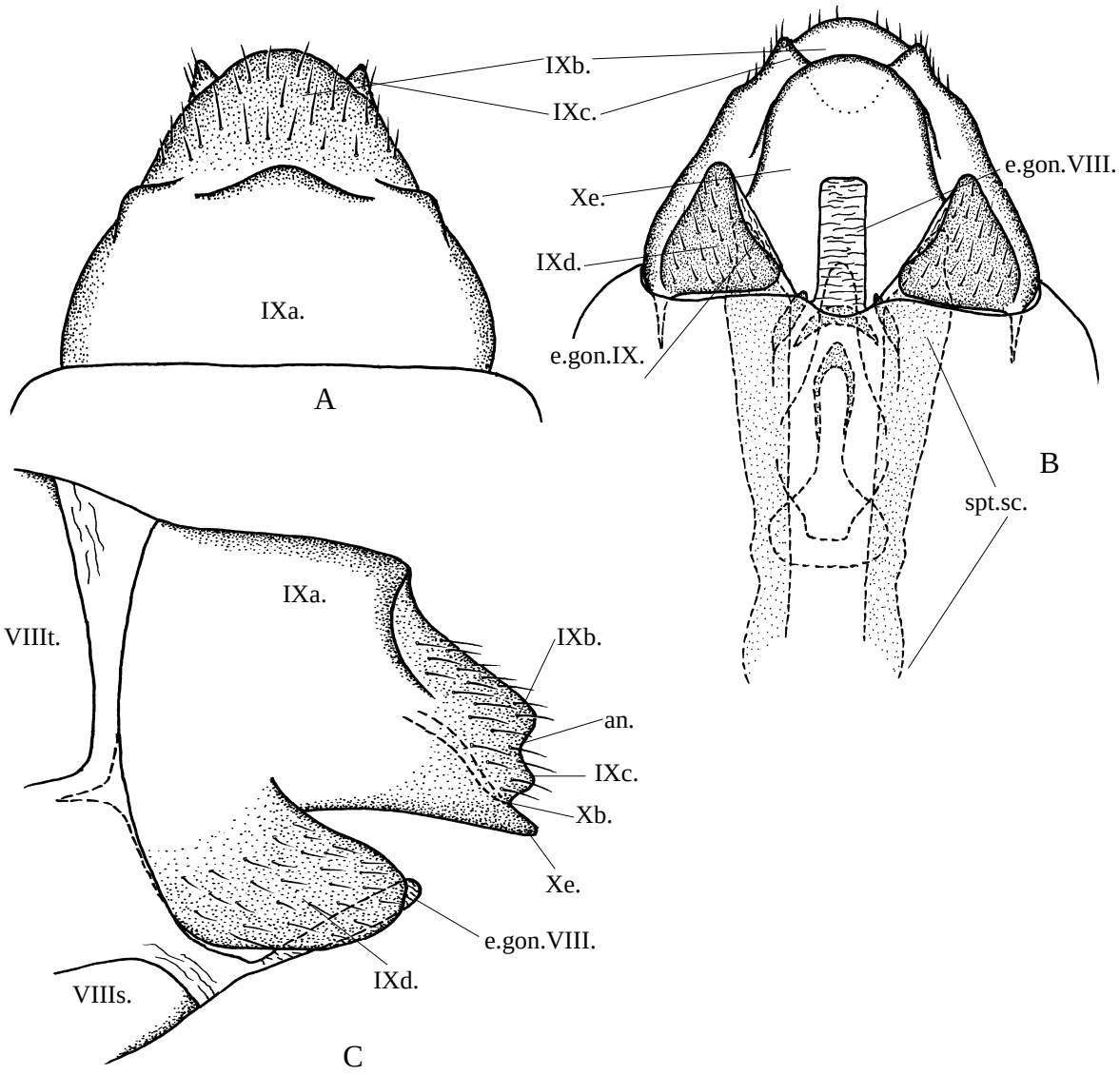


Figure 4.32. Female genitalia of *Apatania zonella* (Zetterstedt). A) dorsal view, B) ventral view, C) left lateral view.

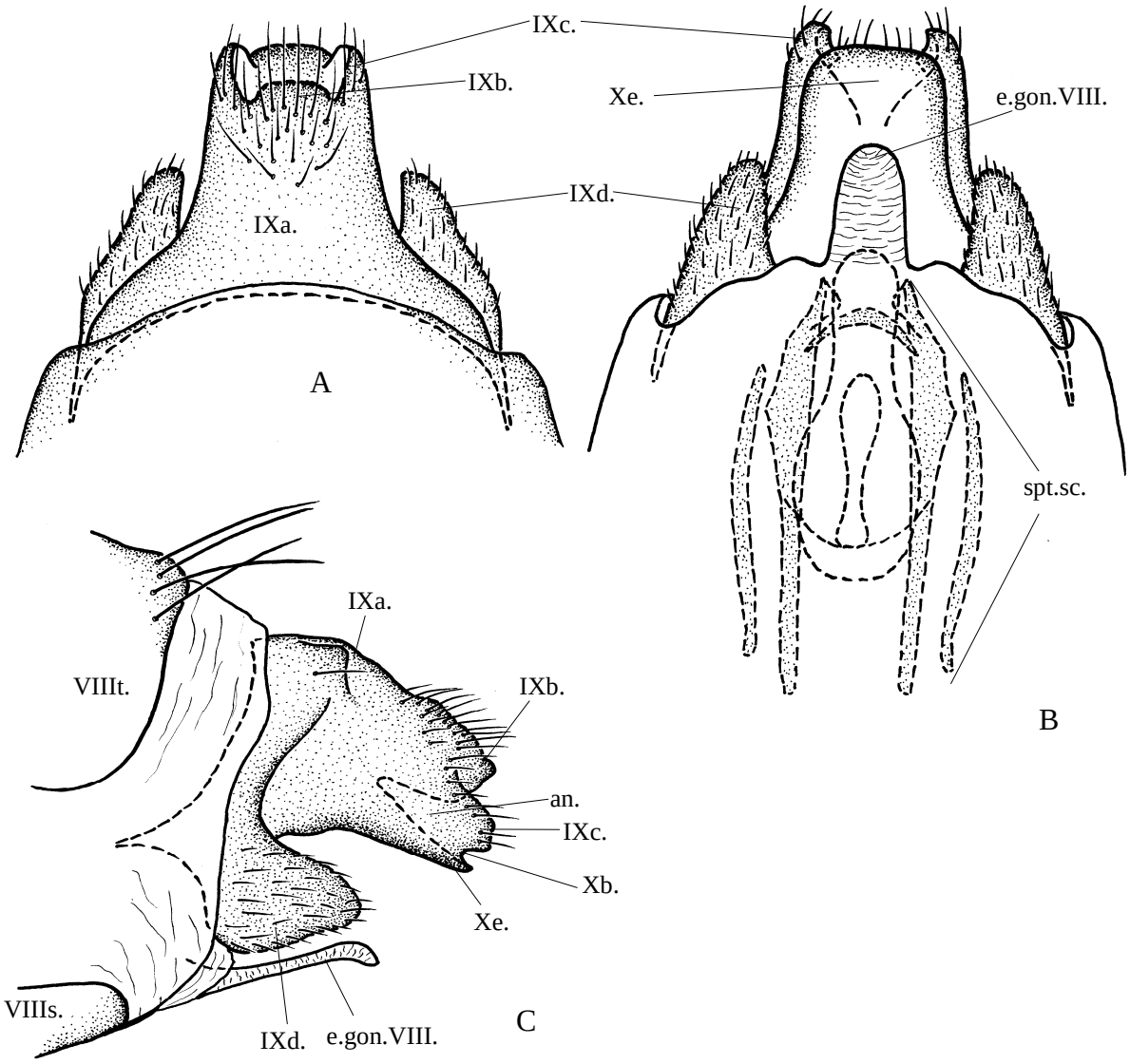


Figure 4.33. Female genitalia of *Apatania dalecarlica* (Forsslund). A) dorsal view, B) ventral view, C) left lateral view.

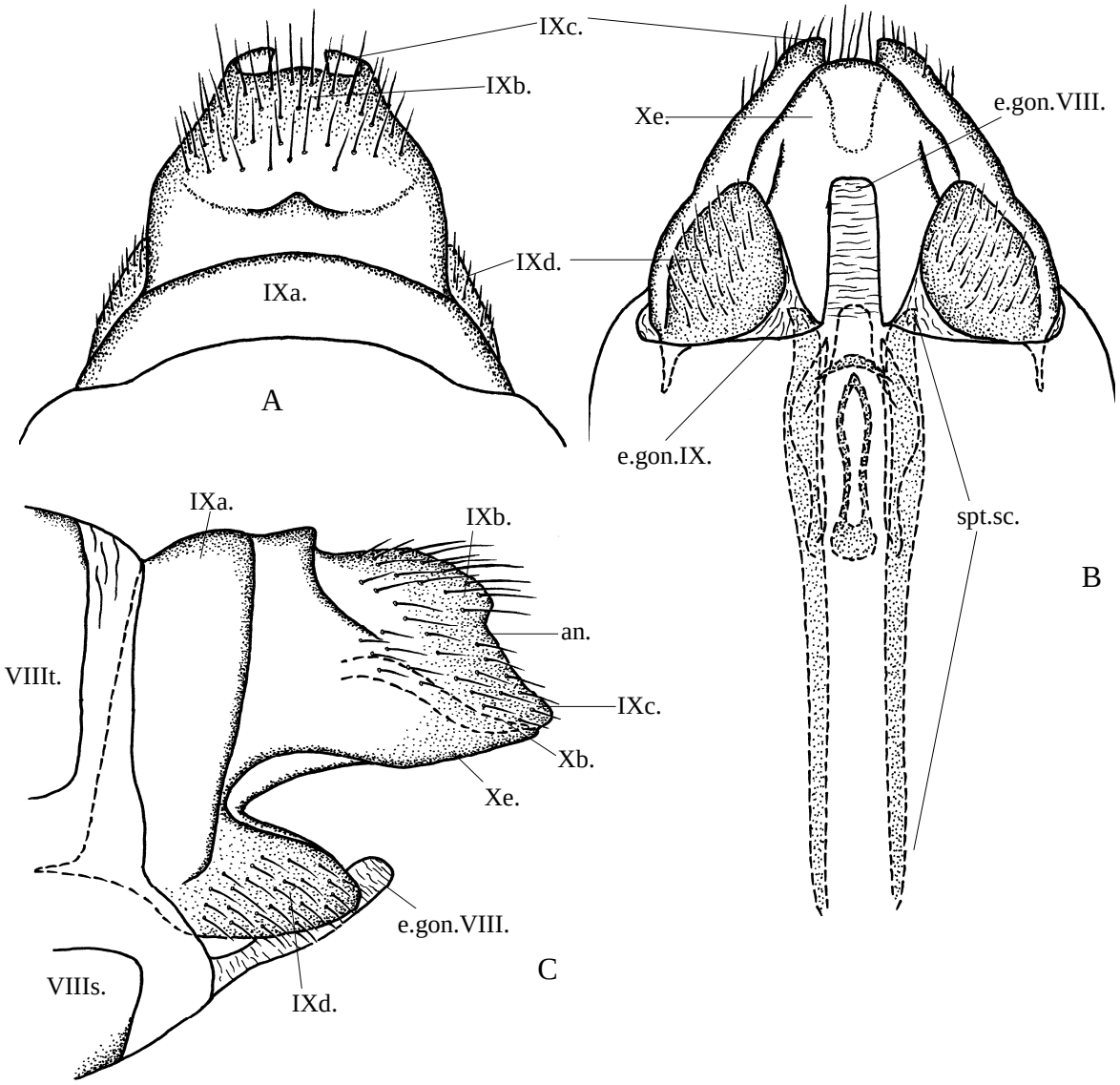


Figure 4.34. Female genitalia of *Apatania nikkoensis* Tsuda. A) dorsal view, B) ventral view, C) left lateral view.

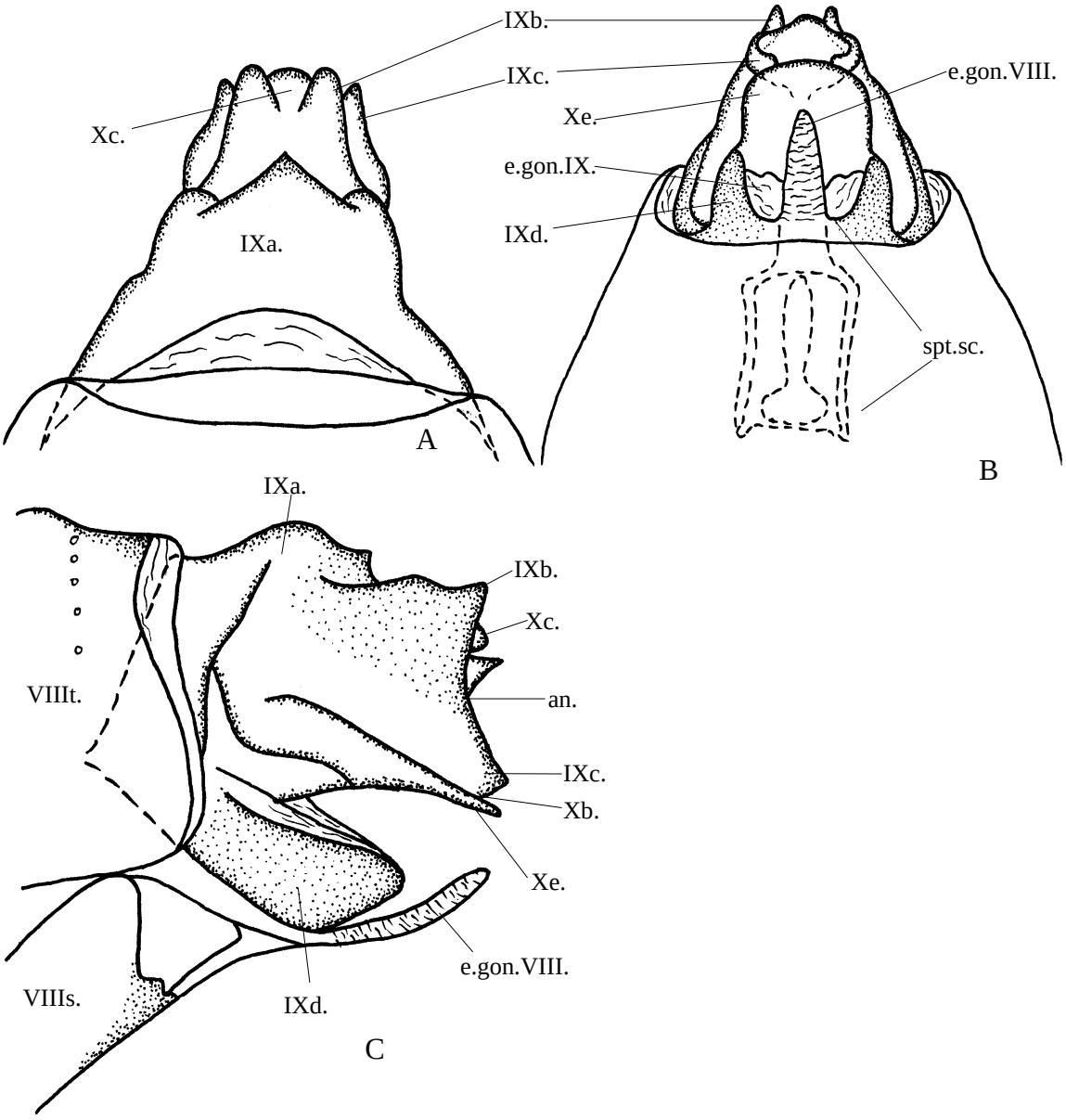


Figure 4.35. Female genitalia of *Apatania lenica* Ivanov. Redrawn from Ivanov 1991. A) dorsal view, B) ventral view, C) left lateral view.

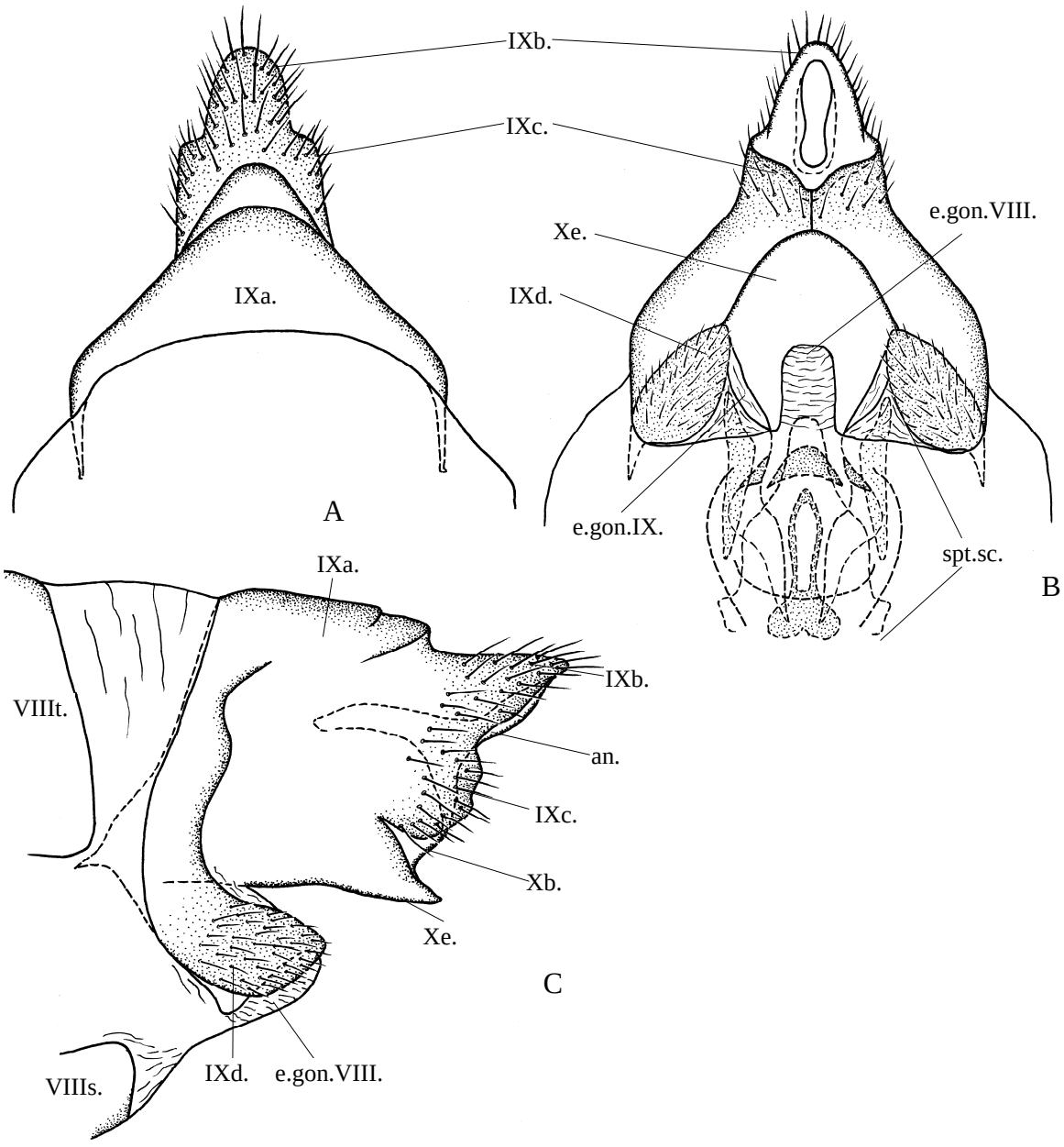


Figure 4.36. Female genitalia of *Apatania majuscula* McLachlan, Hovsgol, Mongolia. A) dorsal view, B) ventral view, C) left lateral view.

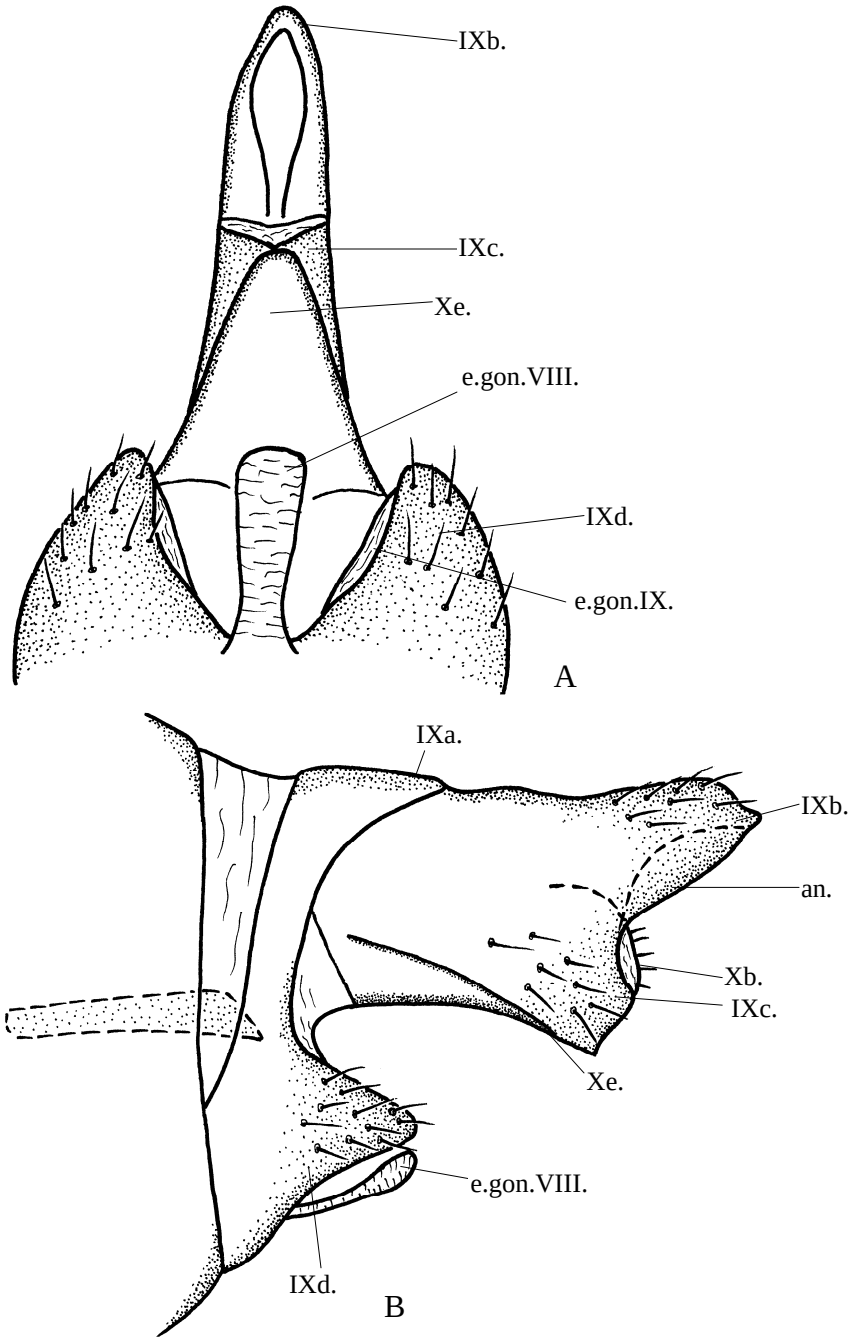


Figure 4.37. Female genitalia of *Apatania majuscula* McLachlan, Altai, Mongolia. Redrawn from Mey 1985. A) ventral view, B) left lateral view.

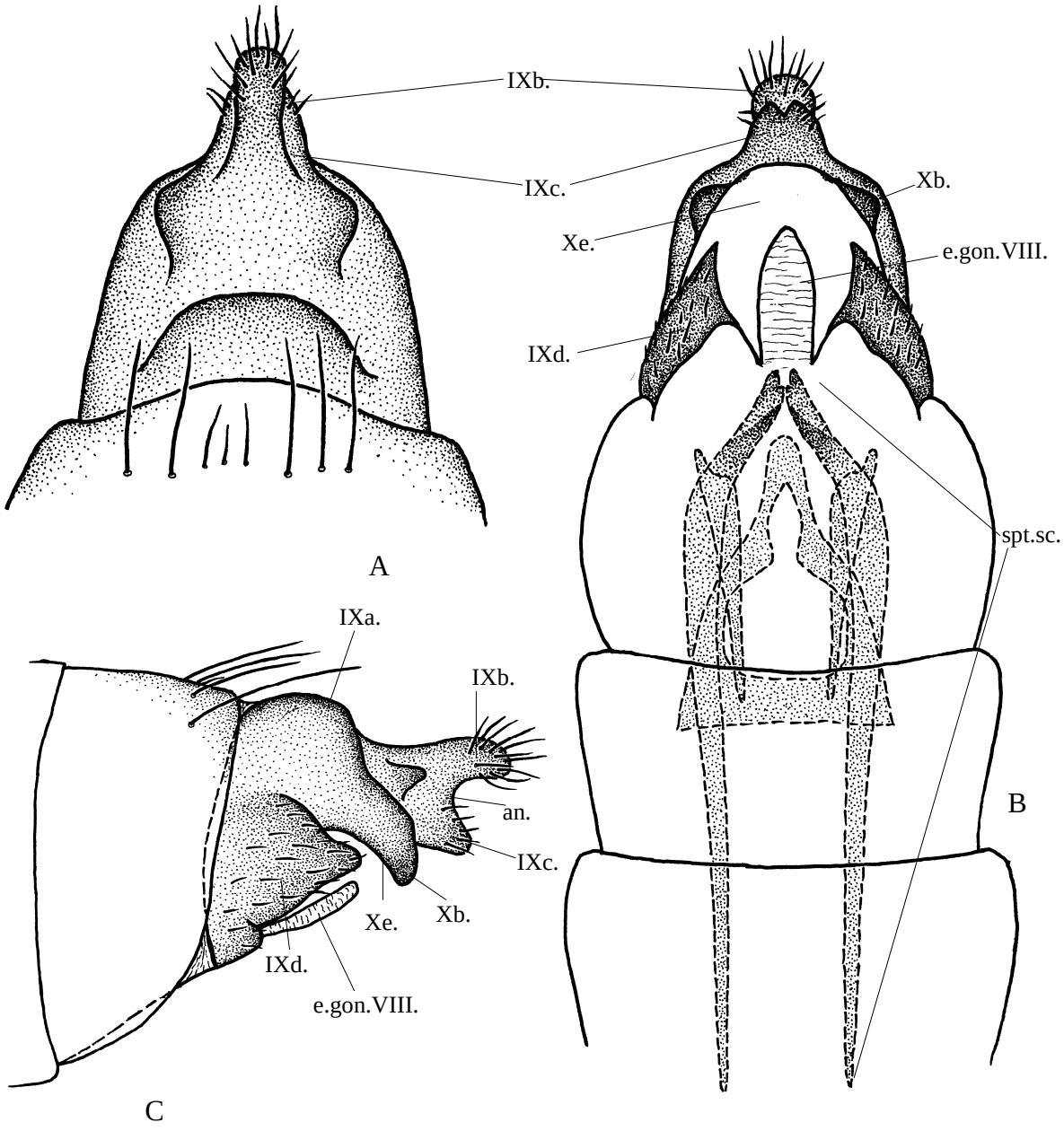


Figure 4.38. Female genitalia of *Apatania sachalinensis* Martynov. A) dorsal view, B) ventral view, C) left lateral view.

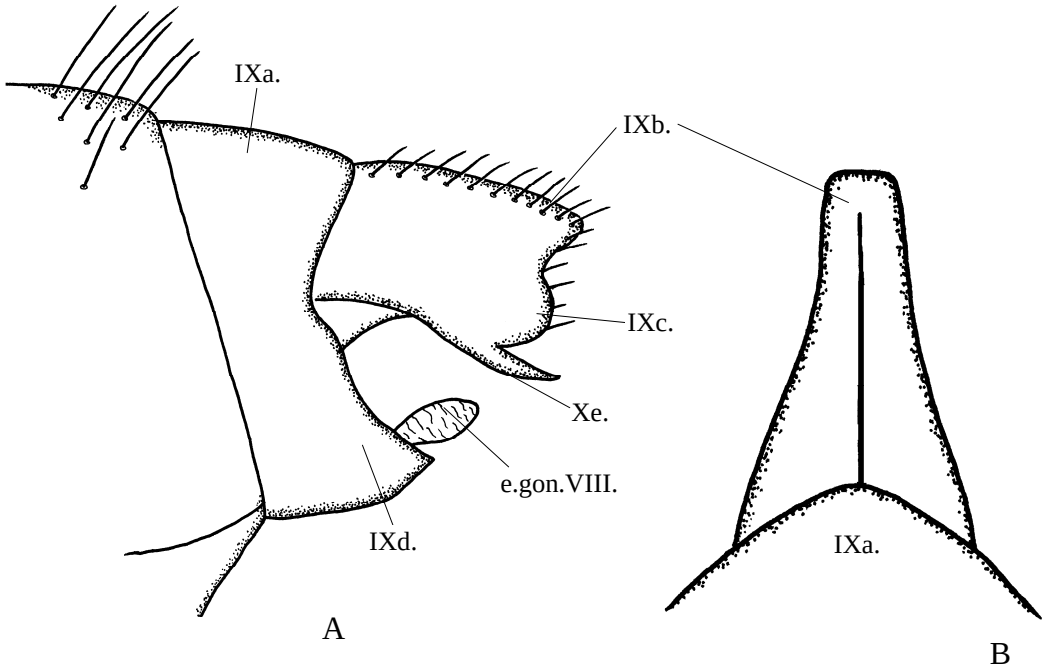


Figure 4.39. Female genitalia of *Apatania copiosa* (McLachlan). Redrawn from Schmid 1953. A) left lateral view, B) dorsal view.

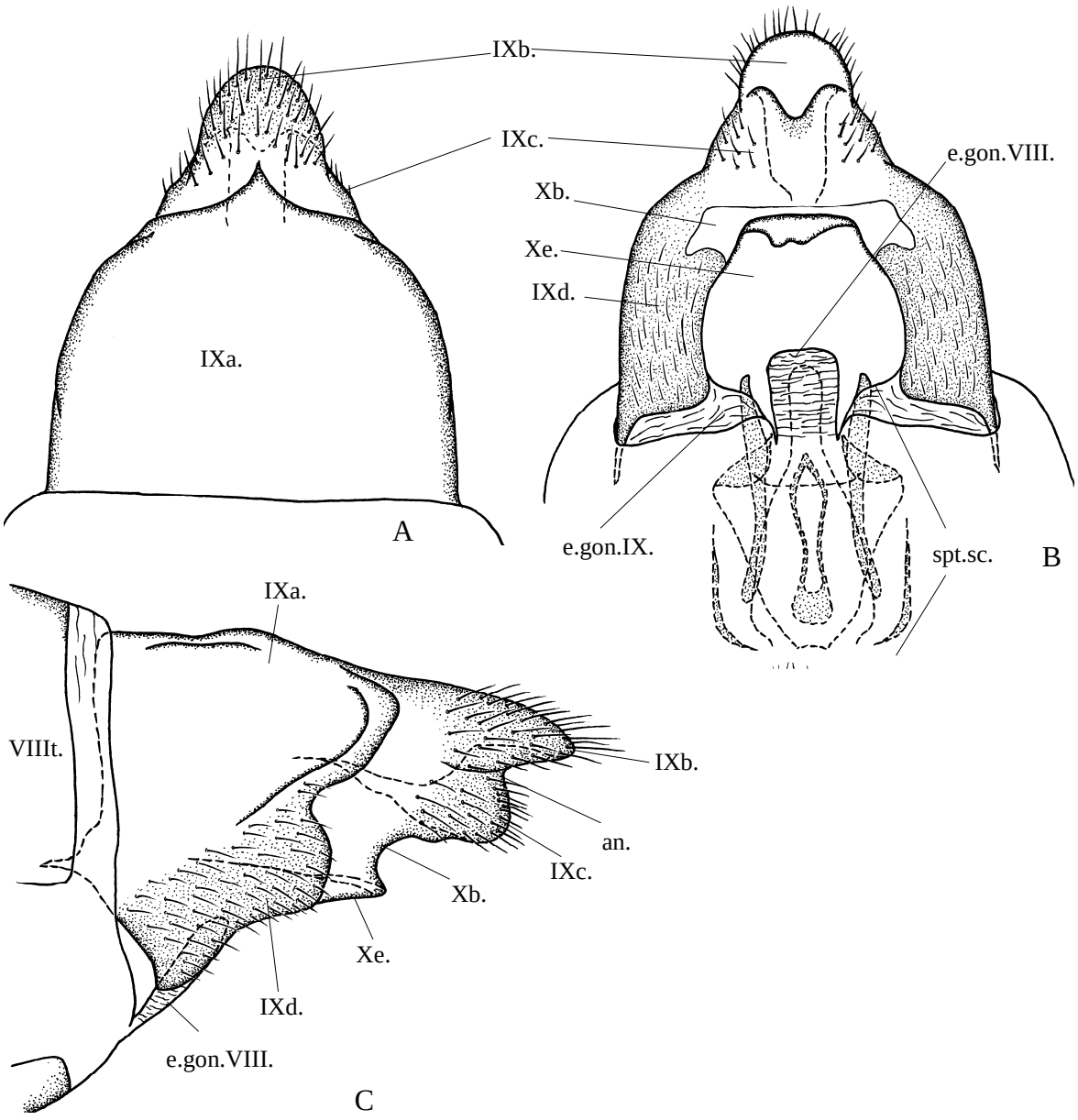


Figure 4.40. Female genitalia of *Apatania hamardabanica* Mey. A) dorsal view, B) ventral view, C) left lateral view.

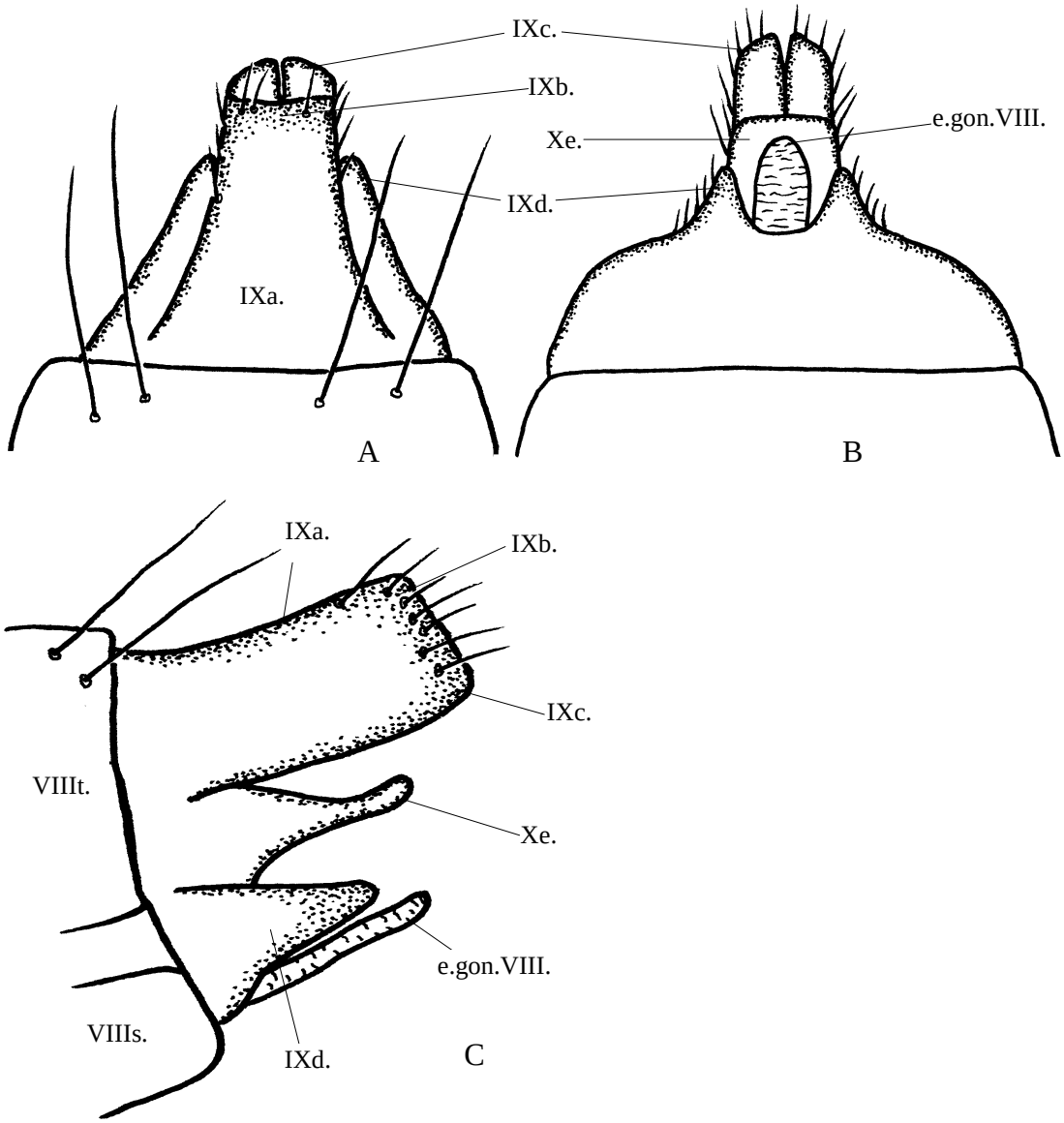


Figure 4.41. Female genitalia of *Apatania sinensis* Martynov. Redrawn from Schmid 1954. A) dorsal view, B) ventral view, C) left lateral view.

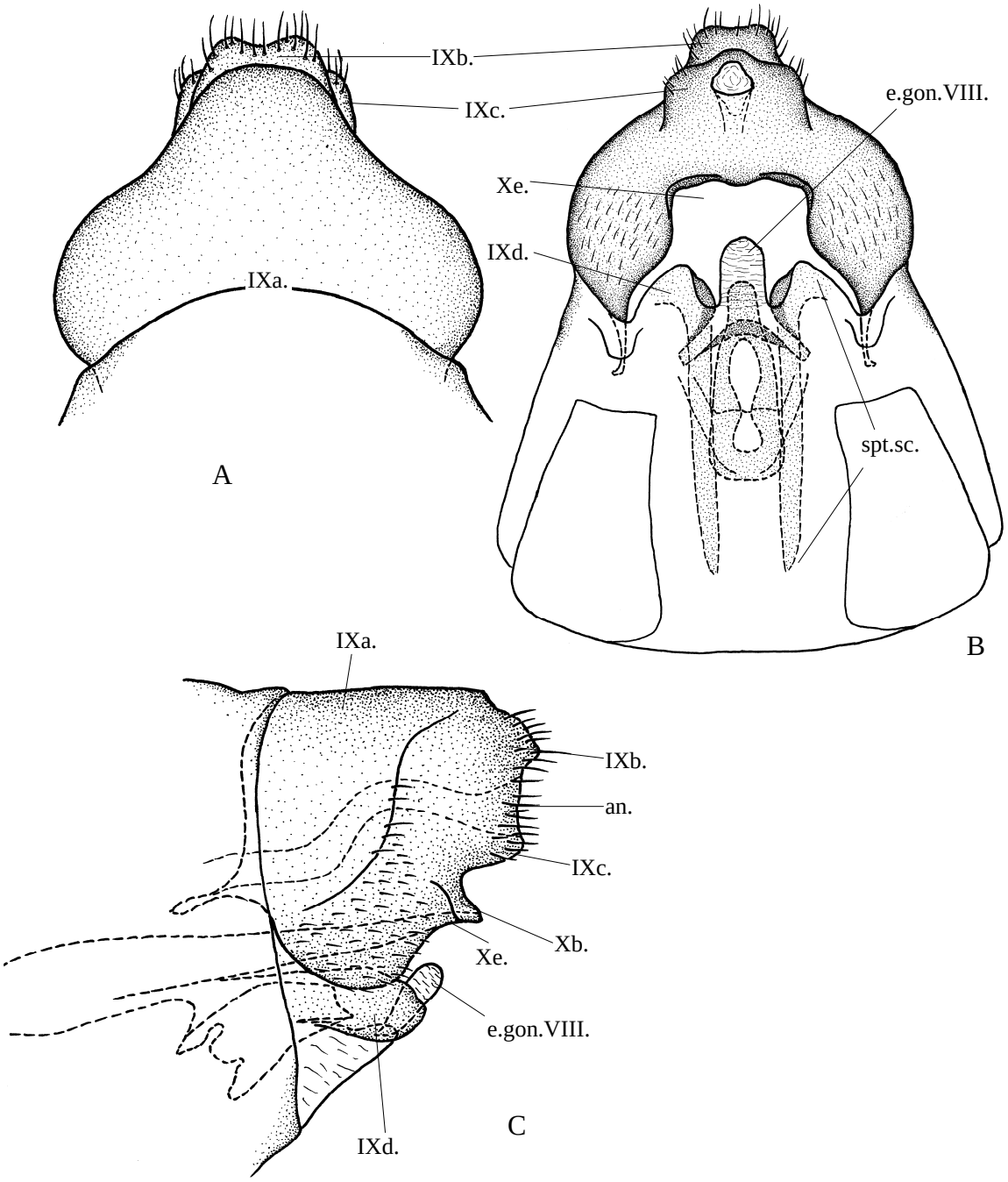


Figure 4.42. Female genitalia of *Apatania maritima* Ivanov. A) dorsal view, B) ventral view, C) left lateral view.

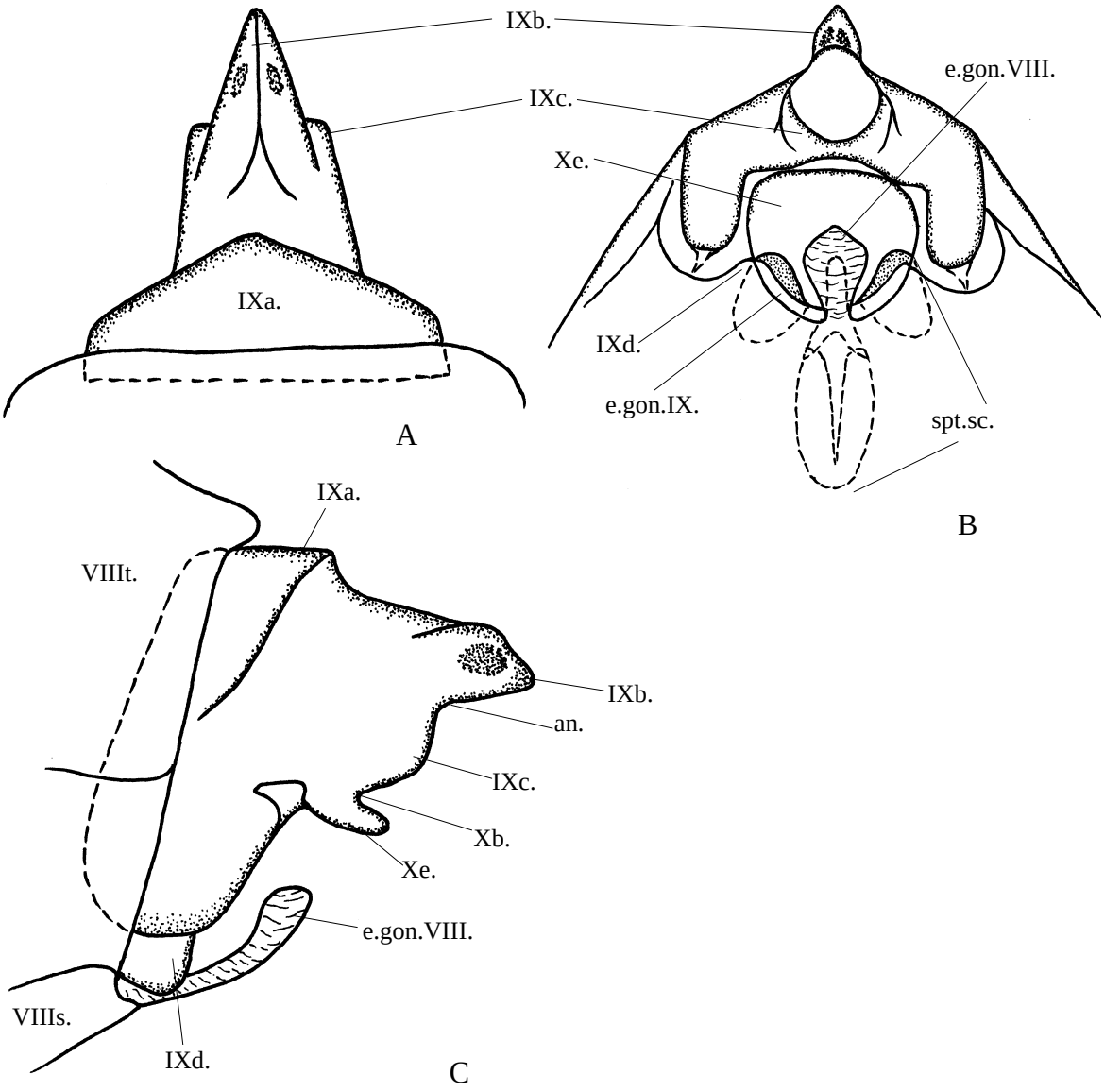


Figure 4.43. Female genitalia of *Apatania sarkandensis* Ivanov. Redrawn from Ivanov 1991. A) dorsal view, B) ventral view, C) left lateral view.

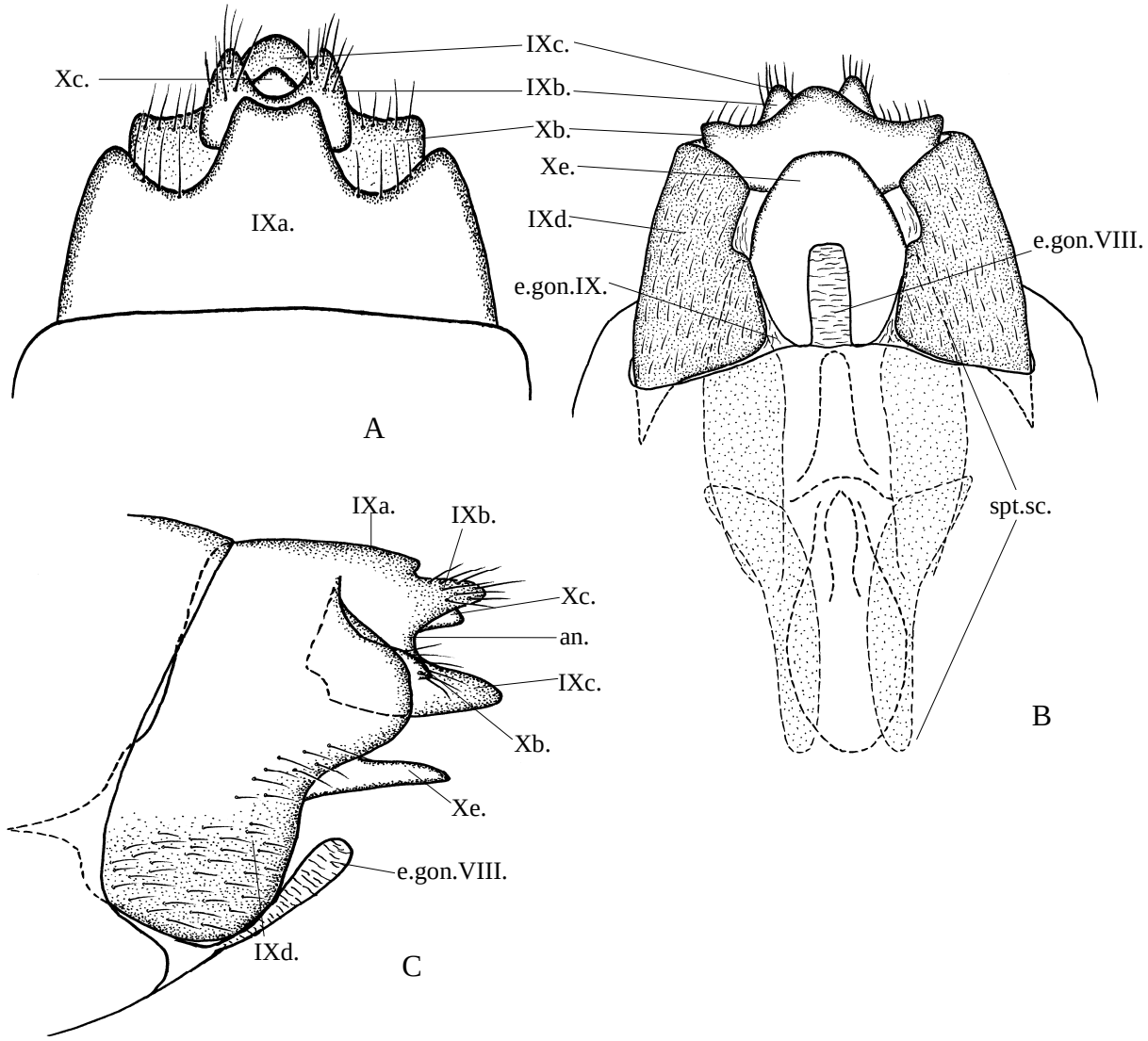


Figure 4.44. Female genitalia of *Apatania chokaiensis* Kobayashi. A) dorsal view, B) ventral view, C) left lateral view.

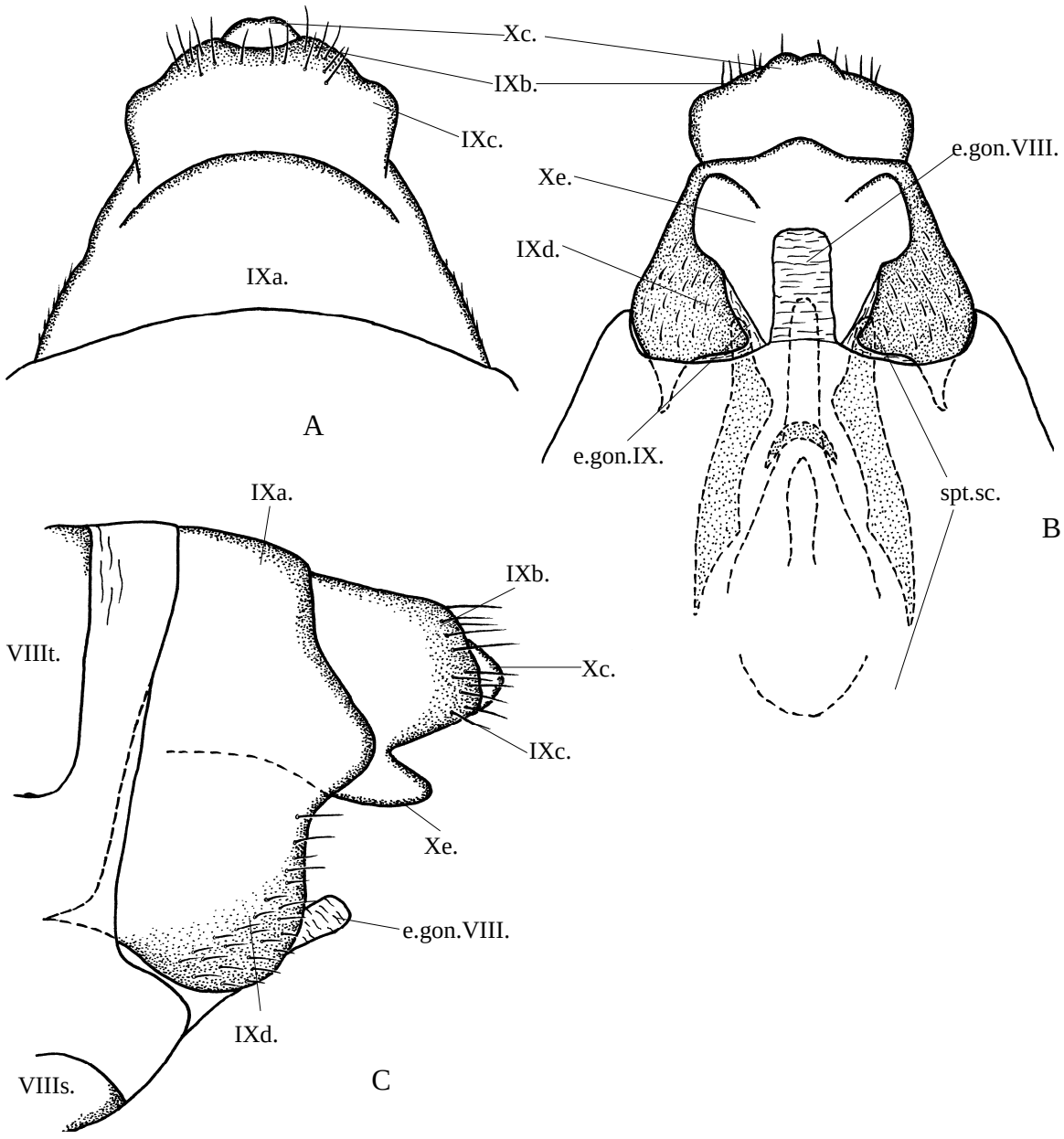


Figure 4.45. Female genitalia of *Apatania ishikawai* Schmid. A) dorsal view, B) ventral view, C) left lateral view.

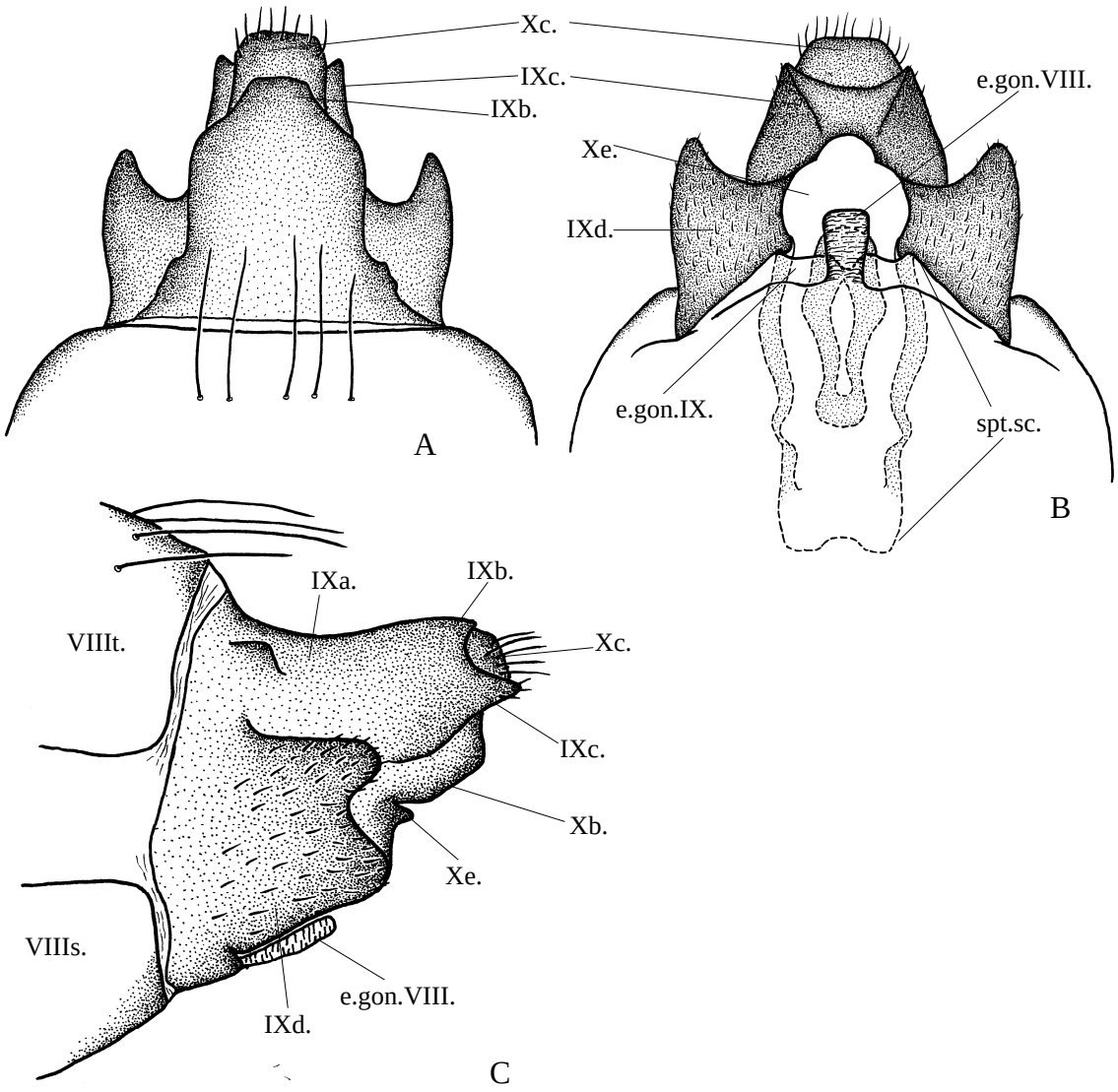


Figure 4.46. Female genitalia of *Apatania parvula* Martynov. A) dorsal view, B) ventral view, C) left lateral view.

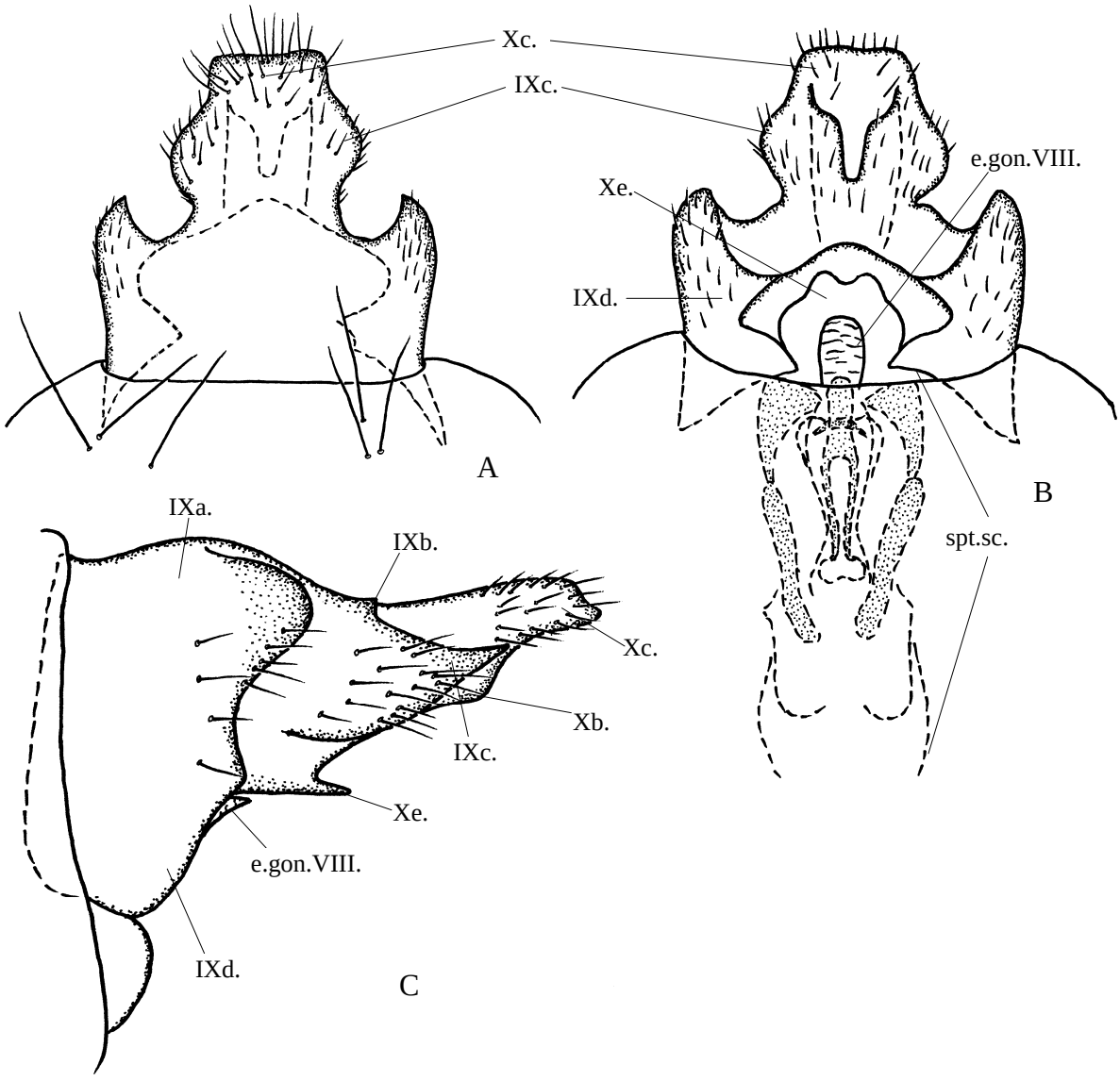


Figure 4.47. Female genitalia of *Apatania insularis* Levanidova. Redrawn from Levanidova 1979. A) dorsal view, B) ventral view, C) left lateral view.

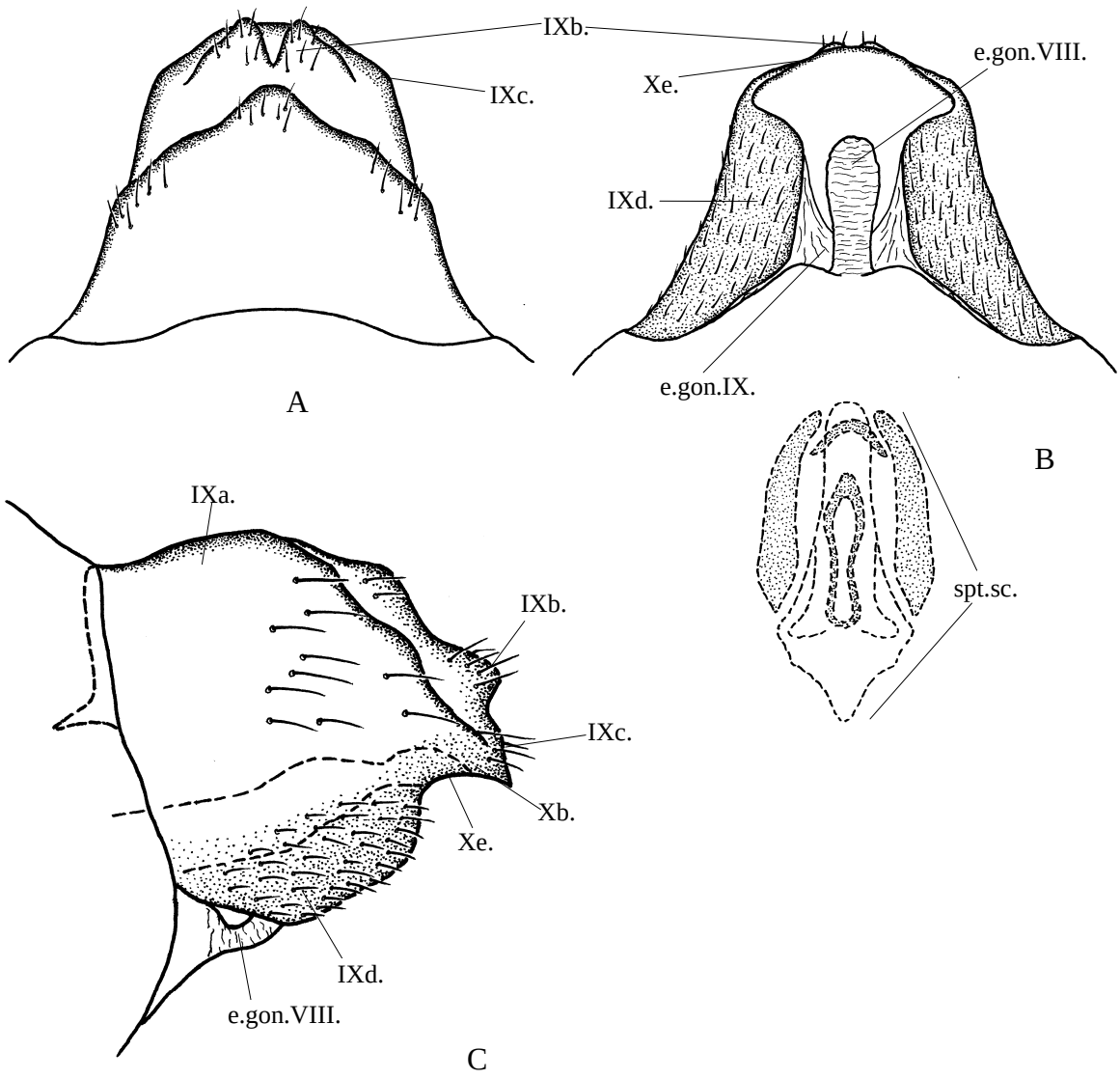


Figure 4.48. Female genitalia of *Apatania stigmatella* (Zetterstedt). A) dorsal view, B) ventral view, C) left lateral view.

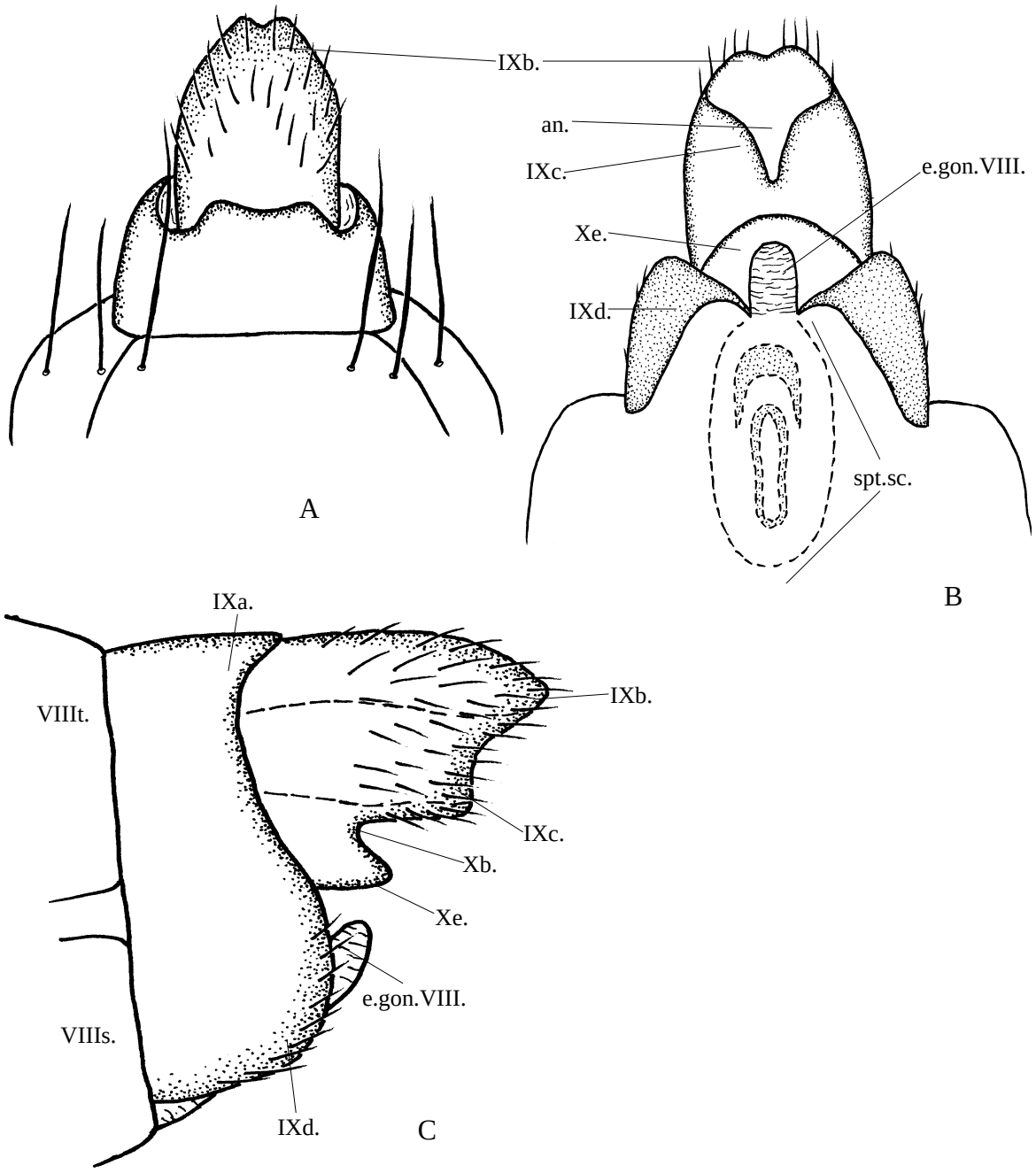


Figure 4.49. Female genitalia of *Apatania mirabilis* Martynov. Redrawn from Martynov 1909. A) dorsal view, B) ventral view, C) left lateral view.

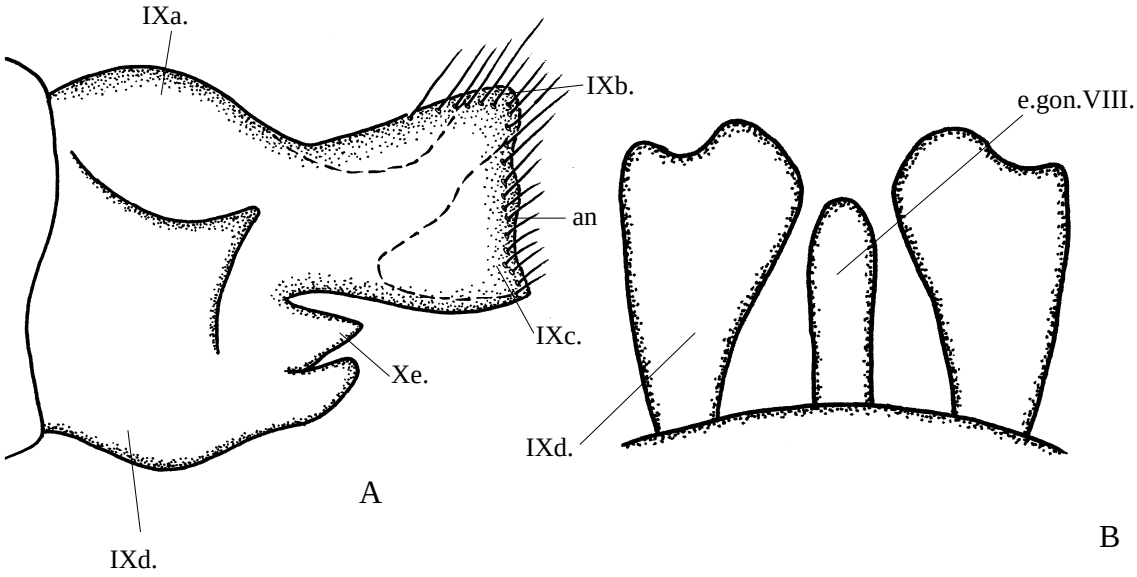


Figure 4.50. Female genitalia of *Apatania yenchingensis* Ulmer. Redrawn from Schmid 1953. A) left lateral view, B) ventral view.

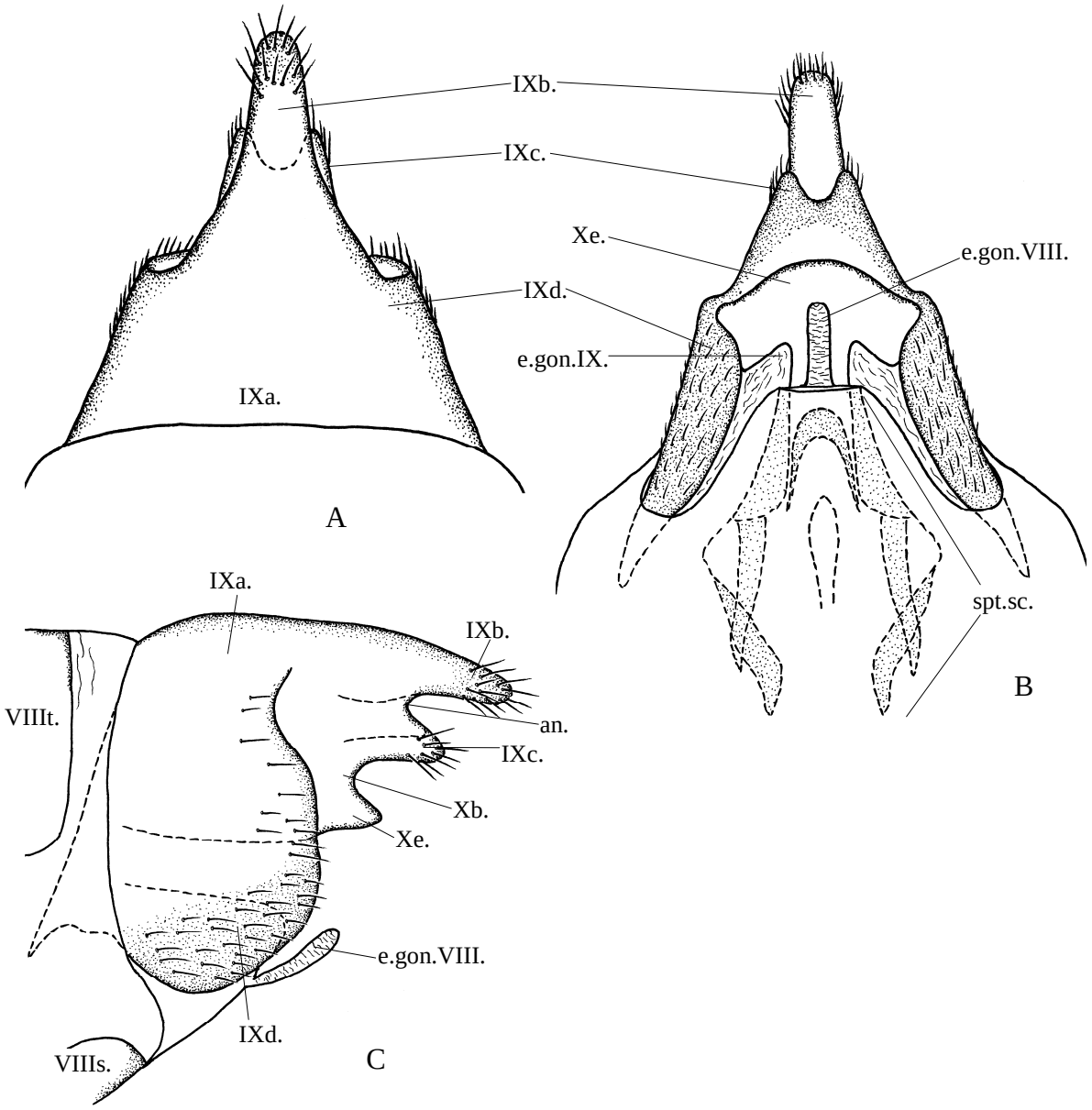


Figure 4.51. Female genitalia of *Apatania aberrans* Martynov. A) dorsal view, B) ventral view, C) left lateral view.

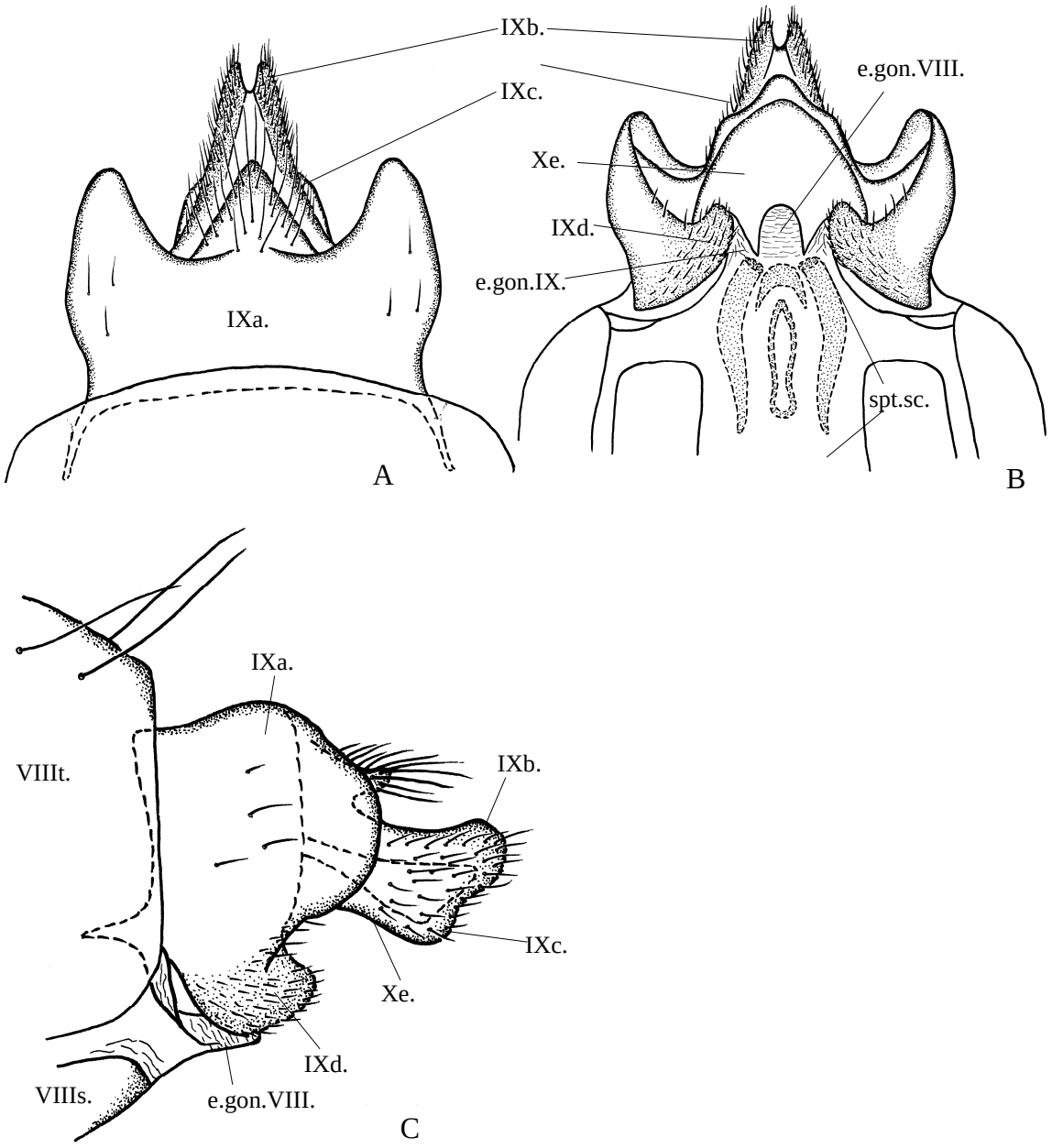


Figure 4.52. Female genitalia of *Apatania crymophila* McLachlan. A) dorsal view, B) ventral view, C) left lateral view.

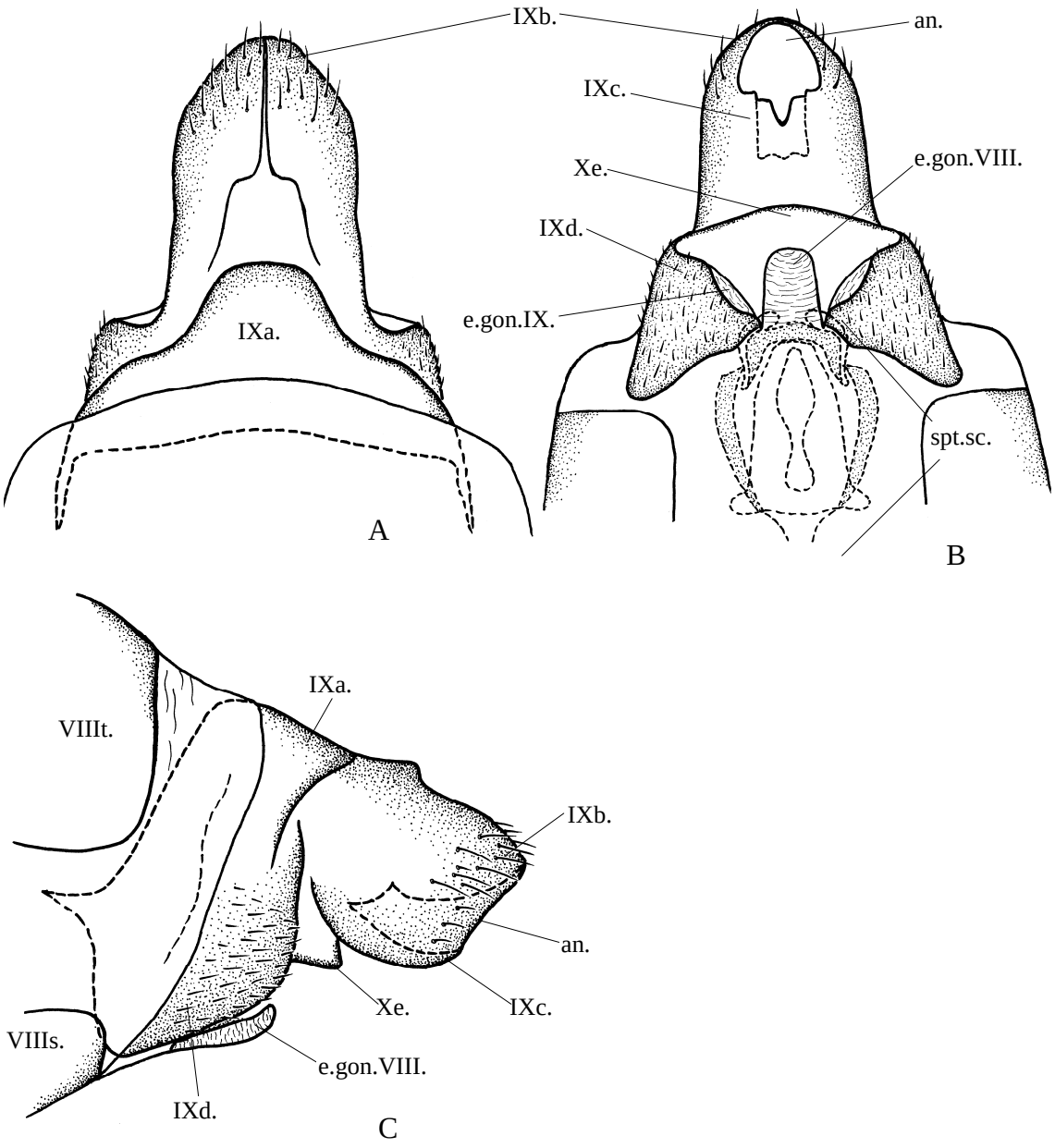


Figure 4.53. Female genitalia of *Apatania complexa* (Martynov). A) dorsal view, B) ventral view, C) left lateral view.

APPENDIX C

Key to males of *Apatania* species of the East Palearctic Region

It should be possible to identify most species simply by direct comparison to illustrations and reference to the species diagnoses and descriptions. The following key is provided to help the user focus on characters most useful in identifying species.

1. Harpagones long (Figs. 4.1-4.4, 4.28-4.30) 2

1’. Harpagones short, or moderately long (Figs. 4.5-4.27) 8

2(1). Male segment IX with ventral processes (Figs. 4.1, 4.2)..... 3 (*A. tsudai* Group)

2’. Male segment IX without ventral processes 4

3(2). Stout bristles present along sides of phallicata (Fig. 4.1) ..... *A.tsudai* Schmid.

3’. Stout bristles absent on phallicata (Fig. 4.2)..... *A.kyotoensis* Tsuda.

4(2’). Inferior appendages each with basal projection (Figs. 4.3, 4.4) .....
.....5 (*A. momoyaensis* Group)

4’. Inferior appendages without basal projections .....6 (*A.* spp. *incertae sedis*)

5(4). Single median process of segment X triangular; phallicata apically with more than 2 bristles (Fig. 4.3) ..... *A.momoyaensis* Kobayashi.

5’. Pair of apically pointed median processes; phallicata apically with 2 bristles (Fig. 4.4)..... *A.tcharvakensis* Ivanov.

6(4’). Pair of long median processes of segment X; external branches of segment X long with hairs at apex; harpago apices each with spine (Figs. 4.29, 4.30).....7

6’. Single short median process apically bifurcate; external branches short, without hairs at apex; harpago apices without spines (Fig. 4.28). ....*A.shirahatai* Kobayashi.

7(6). Slender harpagones each with 2 spines at apex; superior appendages moderately long; parameres thick (Fig. 4.30)..... *A.complexa* (Martynov).

7’. Stout harpagones each with single thick spine at apex; superior appendages fused with external brances of segment X; parameres slender (Figs. 4.29)…. .....*A.crymophila* McLachlan.

8(1). Inferior appendages each with apical ventrolateral projection (Figs. 4.5-4.10) ....9 (*A. zonella* Group)

8’. Inferior appendages without apical ventrolateral projections (Figs. 4.11-4.27)..... 13

9(8). Median process of segment X short, straight (Figs. 4.5-4.7).....10

9’. Median process long, curved ventrad, C-shaped (Figs. 4.8-4.10) 12

10(9). Superior appendages oval, moderately long, separated from external branches; phallicata with bristles subapically both ventrally and dorsally (Figs. 4.5, 4.6)..... 11

10’. Superior appendages fused with external branches; apical portion of phallicata with bristles only dorsally (Fig. 4.7).....*A.nikkoensis* Tsuda.

11(10). External branches of segment X less sinuate ventrally, producing single lobe mesoventrally; median process of segment X triangular, with pointed apex in dorsal view; dorsal bristles of phallicata same size as ventral bristles (Fig. 4.6) ...

..... *A.dalecarlica* (Forsslund).

11’. External branches more sinuate ventrally, producing few lobes mesoventrally; median process triangular, with blunt apex in dorsal view; dorsal bristles of phallicata minute, shorter than ventral bristles (Fig. 4.5) .... *A.zonella* (Zetterstedt).

12(9’). Median process of segment X broad in lateral view, shorter than external branches; phallicata divided sagitally with long notch and inner margins with numerous bristles; parameres obliquely truncate apically (Fig. 4.10) .... *A.mongolica* Martynov.

12’. Median process slender in lateral view, as long as external branches; phallicata notched apically, with several bristles on outer margins; parameres straight, with inner margins slightly serrated (Figs. 4.8, 4.9) ..... *A.majuscula* McLachlan.

13(8’). External branches of segment X long (Figs. 4.11-4.16) .....15 (*A. copiosa* Group)

13’. External branches short (Figs. 4.17-4.27) 19

14(13). External branches of segment X straight, with numerous bristles at apex (Figs. 4.11-4.13) 15

14’. External branches curved mesoventrad at strong angle, with single spine at apex (Figs. 4.14-4.15) 17

15(14). External branches of segment X strongly widened apically, compressed laterally, 2 groups of stout bristles at apex (Fig. 4.13) .....*A.sinensis* Martynov.

15’. External branches slightly widened apically, depressed dorsoventrally, single tuft of stout bristles at apex (Figs. 4.11, 4.12) 16

16(15’). Superior appendages and median process of segment X as long as external branches; harpagones stout, not curved mesad; phallicata with numerous long bristles along lateral edges (Fig. 4.11) .....*A.copiosa* (McLachlan).

16’. Superior appendages and median process half as long as external branches; harpagones slender, curved mesad; phallicata with several short bristles apically (Fig. 4.12)..... *A.hamardabanica* Mey.

17(14’). Each external branch of segment X with short apical spine; phallicata with membranous parts (Figs. 4.14-4.15) 18

17’. Each external branch with long apical spine; phallicata without membranous parts (Fig. 4.16).....*A.sarkandensis* Ivanov.

18(17). External branches of segment X each with short, setose, ventromesal protuberance; harpagones triangular in lateral view; phallicata with pair of membranous parts, their apices with short bristles (Fig. 4.14) ... *A.ulmeri* Schmid

18’. External branches without protuberances; harpagones oval in lateral view; phallicata with pair of membranous parts, their entire venter with long numerous bristles (Fig. 4.15) ..... *A.maritima* Ivanov.

19(13’). Median process of segment X apically bifurcate (Fig. 4.17, 4.18).....
.....20 (*A. chokaiensis* Group)

19’. Median process not apically bifurcate (Figs. 4.19-4.27) 21

20(19). Phallicata with numerous bristles apically; parameres obliquely truncate and serrate apically (Fig. 4.17) ..... *A.chokaiensis* Kobayashi.

20’. Phallicata with few bristles apically; parameres straight apically (Fig. 4.18)…

.....*A.ishikawai* Schmid.

21(19'). Apices of harpagones curved, directed mesoventrad; tuft of short hair present at apicolateral edge of basal segment of each inferior appendage (Figs. 4.19-4.21).. .....22 (*A. parvula* Group)

21'. Apices of harpagones directed mesad, but not ventrad; tufts of short hair absent at apicolateral edges of inferior appendages (Figs. 4.22-4.27) 23

22(21). Body of segment X long slender, triangular and upturned apically in lateral view; harpagones not incised apically, gradually curved ventrad (Fig. 4.21) ....*A.insularis* Levanidova.

22'. Body of segment X rectangular in lateral view; harpagones incised apically, dorsal apex strongly curved ventrad at apex (Figs. 4.19, 4.20) ....*A.parvula* Martynov.

23(21'). Inner surfaces of harpagones with numerous hairs; external branches of segment with apices broadened, triangular (Figs. 4.22, 4.23)..... 24 (*A. stigmatella* Group)

23'. Inner surfaces of harpagones without numerous hairs; external branches slender, cylindrical (Figs. 4.24-4.27).....25

24(23). Superior appendages fused with external branches of segment X; harpagones curved mesad; paired median processes of segment X half as long as external and internal branches (Fig. 4.22) .....*A.stigmatella* (Zetterstedt).

24'. Superiors appendages not fused with external branches of segment X; harpagones not curved mesad; paired median processes same length as external and internal branches of segment X (Fig. 4.23).....*A.mirabilis* Martynov.

25(23’). Phallicata with pair of membranous parts (Figs. 4.24, 4.25). ....26 (*A. siniaevi* Group)

25’. Phallicata without pair of membranous parts.....27 (Species *incertae sedis*)

26(25). Inferior appendage with row of comb-like bristles ventrally; with pair of median process (Fig. 4.25).....*A.pectinella* Mey and Yang.

26’. Inferior appendage without row of comb-like setae ventrally; with single median process (Fig. 4.24).....*A.siniaevi* Mey and Yang.

27(25’). Segment IX with ventral plate (Fig. 4.27) .....*A.aberrans* Martynov.

27’. Segment IX without ventral plate (Fig. 4.26) ..... *A.yenchingensis* Ulmer.

Key to the females of *Apatania* species of the East Palearctic Region

1. Lateral lobe (IXd) of segment IX well developed (Figs. 4.32 -4.38)……. …….....2 (*A.zonella* Group)

1’. Lateral lobe (IXd) of segment IX undeveloped or slightly developed (Figs. 4.31, 4.39-4.53).....7

2(1). Posterior of segment IX (IXc) reaches supragenital plate, producing ear-like process (Figs. 4.32-4.35).....3

2’. Posterior of segment IX (IXc) distant, does not reach supragenital plate, not producing ear-like process 6

3(2). Lateral lobe extended from anterior of IX segment in ventral view and dorsal view (Fig. 4.33)..... *A.dalecarlica* (Forsslund).

3’. Lateral lobe not extended from anterior of IX segment (Figs. 4.32, 4.34, 4.35) ..4

4(3). Vulvar lobe (e.gonVIII) longer than lateral lobe, in ventral view; apically triangular (Fig. 4.35) ..... *A.lenica* Ivanov.

4'. Vulvar lobe (e.gon.VIII) reaches lateral lobe, but not longer; apically rectangular (Figs. 4.32 and 4.34) 5

5(4'). With wide anal opening; pair of ear-like process of segment IX distant from each other; internal spermathecal sclerite (spt.sc) short (Fig. 4.32) ....*A.zonella* (Zetterstedt).

5'. Anal opening narrow; pair of ear-like process of segment IX close to each other; internal spermathecal sclerite (spt. sc) long (Fig. 4.34).....*A.nikkoiensis* Tsuda.

6(2'). Anal opening visible ventrally; internal spermathecal sclerite short (Figs. 4.36, 4.37) ..... *A. majuscula* McLachlan.

6'. Anal opening invisible ventrally; internal spermathecal sclerite long (Fig. 4.38).. .....*A.sachalinensis* Martynov.

7(1'). Lateral lobe of segment IX undeveloped (Figs. 4.40, 4.43, 4.44 and 4.48).....8

7'. Lateral lobe of segment IX slightly developed (Figs. 4.31, 4.46, 4.47 and 4.52)... 15

8(7). Anal opening visible ventrally (Figs. 4.40, 4.43 and 4.49).....9

8'. Anal opening invisible ventrally (Figs. 4.44 and 4.45).....12

9(8). Supragenital plate posteriorly with strongly sclerotized margin (Fig. 4.40); vulvar lobe rectangular ..... *A.hamardabanica* Mey.

9'. Supragenital plate posteriorly without strongly sclerotized margin; vulvar lobe other shape 10

10(9’). Posterior of IX segment narrow, with dark patches on dorsal sides (Fig. 4.43); vulvar lobe kite-like ..... *A.sarkandensis* Ivanov.

10’. Posterior of IX segment broad, without dark patches on dorsal sides (Figs. 4.49 and 4.53); vulvar lobe finger-like 11

11(10). Segment IX (IXb) posteriorly slightly notched; anal opening large (Fig. 4.49)..... .....*A.mirabilis* Martynov.

11’. Segment IX (IXb) posteriorly not notched; anal opening smaller (Fig. 4.53)..... ..... *A.complexa* (Martynov).

12(8’). Spermathecal sclerite (spt.sc) separate from external gonopods (Fig. 4.48) ....*A.stigmatella* (Zetterstedt).

12’. Spermathecal sclerite (spt.sc) not separate from external gonopods (Figs. 4.44, 4.45 and 4.51) 13

13(12’). Vulvar scales (e.gon.IX) well developed, produced as pair of finger-like triangular process, visible in ventral view (Fig. 4.51) .....*A.aberrans* Martynov.

13’. Vulvar scales (e.gon.IX) slightly developed, not as above (Figs. 4.44, 4.45)....14

14(13’). Segment IX (IXb and IXc) with strongly projected, finger-like process; IXb posteriorly deeply nothced in dorsal view (Fig. 4.44) .... *A.chokaiensis* Kobayashi.

14’. Segment IX (IXb and IXc) fused with slight protuberance; IXb posteriorly slightly notched in dorsal view (Fig. 4.45) .....*A.ishikawai* Schmid.

15(7’). Lateral lobe (IXd) of IX segment connected with lateral projection and produced as wing-like protuberance (Figs. 4.31, 4.46, 4.47 and 4.52).....16

15’. Lateral lobe (IXd) of IX segment not producing wing-like protuberance (Figs. 4.39, 4.41 and 4.42) 19

16(15). Segment X (Xc) strongly produced, exceeding IX segment (Figs. 4.46-4.47), or slightly produced.....17

16’. Segment X (Xc) not produced (Fig. 4.52) .....*A.crymophila* McLachlan.

17(16). Posterior of segment IX (IXb) dorsally shorter than IXc, not exceeding segment X (Xc) (Figs. 4.46-4.47) 18

17’. Posterior of segment IX (IXb) dorsally longer than IXc, exceeding segment X (Xc) (Fig. 4.31) .....*A.tsudai* Schmid.

18(17). Anal opening visible ventrally (Fig. 4.47).....*A.insularis* Levanidova.

18’. Anal opening invisible ventrally (Fig. 4.46).....*A.parvula* Martynov.

19(15’). Posterior of segment IX (IXb and IXc) strongly elongated, rectangular in lateral view (Figs. 4.39, 4.41 and 4.50) 20

19’. Posterior of segment IX (IXb and IXc) slightly elongated, subtriangular in lateral view (Fig. 4.42).....*A.maritima* Ivanov.

20(19). Supragenital plate (Xe) strongly produced posteriorly with sharp angle (Fig. 4.39) .....*A.copiosa* (McLachlan).

20’. Supragenital plate (Xe) without such projection (Figs. 4.41 and 4.50); 21

21(20’). Vulvar lobe exceeds lateral lobes of segment IX (Fig. 4.41).....
.....*A.sinensis* Martynov.

21’. Vulvar lobe shorter than lateral lobe of segment IX (Fig. 4.50).....
..... *A.yenchingensis* Ulmer.

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